RESEARCH FOR COMMERCIAL PRODUCTION OF FISH ON FLOODED RICE ACREAGE

UNIVERSITY OF MICHIGAN
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MAIN READING ROOM

HEARING

BEFORE A

SUBCOMMITTEE OF THE COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE UNITED STATES SENATE

EIGHTY-FIFTH CONGRESS

FIRST SESSION

ON

S. 1552

A BILL TO AUTHORIZE THE SECRETARY OF AGRICULTURE TO ESTABLISH A PROGRAM FOR THE PURPOSE OF CARRYING ON CERTAIN RESEARCH AND EXPERIMENTATION TO DEVELOP METHODS FOR THE COMMERCIAL PRODUCTION OF FISH ON FLOODED RICE ACREAGE IN ROTATION WITH RICE FIELD CROPS, AND FOR OTHER PURPOSES

JULY 8, 1957

Printed for the use of the Committee on Interstate and Foreign Commerce

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CONTENTS

Statement of—
Callison, Charles H., conservation director, National Wildlife Federation, 232 Carroll Street NW., Washington, D. C. — Page 35
Fulbright, Hon. J. W., United States Senator from the State of Arkansas — 2
Jackson, Charles E., general manager, National Fisheries Institute, Inc., 1614 20th Street NW., Washington, D. C. — 37
Meehean, Dr. O. Lloyd, Office of Program Review, United States Fish and Wildlife Service, United States Department of Interior, Washington, D. C., accompanied by W. F. Carbine, Branch of Fisheries — 29
Prewitt, Roy, Lonoke, Ark. — 23
White, Dr. John W., associate director, Arkansas Agricultural Experiment Station, University of Arkansas, Fayetteville, Ark. — 15
Statement submitted by—
Seaman, E. A., executive secretary, Sport Fishing Institute, Bond Building, Washington 5, D. C. — 40
Letter from—
Trimble, Hon. J. W., Member of Congress from the Third District of Arkansas, dated July 5, 1957 — 39
Reports from—
General Accounting Office, dated April 2, 1957 — 45
Interior Department, dated April 15 and July 5, 1957 — 45 and 40
Justice Department, dated March 29, 1957 — 46
Miscellaneous:
Illustration of game and food fishes generally raised at Federal hatcheries — 47

RESEARCH FOR COMMERCIAL PRODUCTION OF FISH ON FLOODED RICE ACREAGE

MONDAY, JULY 8, 1957

UNITED STATES SENATE,
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
SPECIAL SUBCOMMITTEE,
Washington, D. C.

The subcommittee met at 10:35 a. m., in room G–16, United States Capitol, Hon. Ralph W. Yarborough presiding.

Senator YARBOROUGH. Gentlemen, this hearing is called for the purpose of taking testimony regarding S. 1552, a bill introduced by Senator Fulbright, which proposes that the Government enter into a contract with the University of Arkansas, for the establishment of an experimental station or stations, to carry out a program of research and experimentation in fish farming in rice growing areas.

(S. 1552 follows:)

[S. 1552, 85th Cong., 1st sess.]

A BILL To authorize the Secretary of Agriculture to establish a program for the purpose of carrying on certain research and experimentation to develop methods for the commercial production of fish on flooded rice acreage in rotation with rice field crops, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of Agriculture is authorized and directed to contract with the University of Arkansas for the establishment of an experiment station or stations within the State of Arkansas for the purpose of carrying on a program of research and experimentation—

(1) to determine species of fishes most suitable for culture on a commercial basis in shallow reservoirs and flooded rice lands;

(2) to determine methods for production of fingerling fishes for stocking in commercial reservoirs;

(3) to develop methods for the control of parasites and diseases of brood fishes and for fingerlings prior to stocking;

(4) to develop economical methods for raising the more desirable species of fishes to a marketable size;

(5) to determine the effects of fish-rice rotations, including crops other than rice commonly grown on rice farms, upon both the fish and other crops;

(6) to develop methods for the control of obnoxious weeds developing in the fish-rice rotation; and

(7) to develop suitable methods for harvesting the fish crop and preparing it for marketing, including a study of sport fishing as a means of such harvest.

SEC. 2. For the purpose of carrying out the provisions of this Act, the Secretary of Agriculture is authorized (1) to acquire by purchase, condemnation, or otherwise such suitable lands, to construct such buildings, to acquire such equipment and apparatus, and to employ such officers and employees as he deems necessary; (2) to cooperate with State and other institutions and agencies upon such terms and conditions as he determines to be appropriate; and (3) to make public the results of such research and experiments conducted pursuant to the first section of this Act.

NOTE.—Staff member assigned to this hearing: Milo Moore.

SEC. 3. The United States Fish and Wildlife Service of the Department of the Interior is authorized to cooperate in carrying out the provisions of this Act by furnishing such information and assistance as may be requested by the Secretary of Agriculture.

SEC. 4. There are hereby authorized to be appropriated such sums as may be necessary to carry out the provisions of this Act.

Senator YARBOROUGH. It has been reported that within the past few years some 800,000 water storage ponds have been built by farmers in the United States for the purpose of irrigating farmland during the dry season and that the farmers have shown a great interest in the growing of fish in privately owned ponds.

Senator Fulbright, in introducing this bill, S. 1552, has brought to the attention of Congress the need for the establishment of a Federal fisheries experimental station in the State of Arkansas to study the possibilities of commercially farming food fish in ricegrowing areas.

I might say that such a program would benefit the whole Nation, and the research would aid all of the ricegrowing States by finding new ways to increase production.

We are pleased now to call the first witness on this bill, and the first witness is the Honorable J. W. Fulbright, United States Senator from Arkansas.

Senator Fulbright.

STATEMENT OF HON. J. W. FULBRIGHT, A UNITED STATES SENATOR FROM THE STATE OF ARKANSAS

Senator FULBRIGHT. Mr. Chairman, I appreciate very much indeed being given this opportunity to appear before the subcommittee to discuss this bill to establish an experiment station in Arkansas for research into fish farming on idle riceland. The subject of the bill is one which merits national attention, and I am pleased that the subcommittee has called a public hearing to examine the proposal.

And, Mr. Chairman, I would ask permission to insert as a part of your record particularly, an act of the State of Arkansas, Act 65 of 1957, dealing with this subject, which is one of the objections that has been raised in the past by people interested in this subject. That is the objection that the sale of game fish is not properly regulated, and we believe in Arkansas that it is now under this act; and I would like that to be made a part of the record.

Senator YARBOROUGH. It is so ordered that it be made a part of the record.

(The act referred to is as follows:)

ACT 65 OF 1957

AN ACT To define domestic fish and to declare the policy of the State in regard thereto

BE IT ENACTED *by the General Assembly of the State of Arkansas:*

SECTION 1. As used in this Act, the expression "domestic" fish shall be understood to mean fish that are spawned and raised in privately owned waters, as defined in Section 1 of Act 152 of the General Assembly of Arkansas of the year 1955. Such domestic fish are declared to be the private property of the owner of the privately owned waters in which they are found.

SECTION 2. The production, harvesting, and sale of domestic fish are declared to be lawful, as of common right, and not as privilege; shall be aided and encouraged by the State; and shall not be subject to prohibition, restriction, or

licensing by the State or any of its agencies, except as provided in Section 3 of this Act.

SECTION 3. Persons engaged, or planning to engage, in the business of producing and selling domestic fish, prior to selling or offering for sale any such fish, shall in writing, on such forms as may be provided by the State Game and Fish Commission for such purpose, register with said Commission his status as a producer of domestic fish reporting his name and address, the location of the privately owned waters owned or leased by him, the species of fishes being raised or proposed to be raised therein for sale, and such other information with respect thereto as the Commission may reasonably require. Each such registrant shall be by the Commission assigned a number, which shall be promptly delivered by the Commission to the registrant. No domestic fish, except such species, if any, as may be expressly exempted from this requirement by order of the Commission, shall be sold or transported for sale unless accompanied by an invoice or bill of lading or document of corresponding import describing such fish and bearing the name and registration number of the person in whose privately owned (or leased) waters such fish were produced. Any person violating this Act shall be guilty of a misdemeanor and shall be fined in an amount not exceeding One Hundred ($100.00) Dollars for each offense.

SECTION 4. All laws and parts of laws which are in conflict herewith are, to the extent of such conflict, hereby repealed.

SECTION 5. Whereas the citizens of Arkansas are being deprived of a source of wholesome and palatable food in the form of domestic fish, and of a market for the crops of such fish produced in this State, by confusion with respect to the laws applicable to the production and sale of such fish: now, therefore, an emergency is declared to exist, and this Act, being immediately necessary for the preservation and protection of the public health, safety and welfare, shall take effect and be in force immediately from and after its enactment and approval.

Approved February 15, 1957.

Senator FULBRIGHT. I also have two other documents; one is the proposed fish-rice research project which has been prepared by experts in the field. Whether or not you would wish to print that in the record, that is for the committee to decide, but I think that it ought to be made available to the committee if you care to make it a part of the record.

Senator YARBOROUGH. It is ordered to be made a part of the record.

(The document referred to follows:)

A PROPOSED FISH-RICE RESEARCH PROJECT [1]

Title: Commercial production of fish in rice-field rotations and as a separate crop.

OBJECTIVES

1. To determine species of fishes most suitable for culture on a commercial basis in shallow reservoirs and flooded ricelands in Arkansas.
2. To determine methods for production of fingerling fishes for stocking in commercial reservoirs.
3. To develop methods for the control of parasites and diseases of brood fishes and of fingerlings prior to stocking.
4. To develop economical methods for raising the more desirable species of fishes to a marketable size.
5. To determine the effects of fish-rice rotations, including crops other than rice commonly grown on rice farms, upon both the fish and other crops.
6. To develop methods for the control of obnoxious weeds developing in the fish-rice rotation.
7. To develop suitable methods for harvesting the fish crop and preparing it for marketing. Sport fishing will be studied as a means of harvest and use of the facility.

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[1] Developed for the University of Arkansas Agricultural Experiment Station by H. S. Swingle of the Alabama Agricultural Experiment Station, and modified by the staff of the Arkansas station and by the board of directors of the Arkansas Fish Farmers' Cooperative.

REASONS FOR UNDERTAKING THE WORK

Arkansas is especially favored in respect to both water supplies and productive soils. As a result, rice culture has developed extensively in the eastern half of the State. In rice culture it is customary to fallow or grow other crops on the land after 2 or more years in rice for the control of certain weeds and other pests. These fields remain in a lower than rice return use for 1 to 2 or more years. It appears possible to use these fields during this fallowing or rotation period for fish production and thus develop a rice-fish or rice-fish and other crop rotation. Such a rotation should increase the income of Arkansas rice farmers by putting the land to a higher return use.

In addition many acres formerly in rice have been retired because of restrictive quotas. Fish-farming would appear to offer a profitable use of much of this land.

For the above reasons, many Arkansas farmers have become interested in raising fish as a crop and a large acreage is now being used for this purpose. Research is greatly needed upon this new agricultural industry in Arkansas to provide farmers with the information necessary to make fish farming a success in the State. (1)

PREVIOUS WORK AND PRESENT OUTLOOK

The commercial production of fish for food in ponds or reservoirs is an ancient practice. Records as early as 500 B. C. refer to it as a common practice in China (2) and by the year 1358 it was an established industry in Europe. (3) Fish farming is at present an important industry in the following foreign countries: Germany, Poland, Czechoslovakia, France, China, India, Philippines, Japan, and Indonesia.

In the United States, the commercial production of trout in raceways is a profitable type of fish culture which has been practiced extensively for over 50 years. The commercial production in ponds of minnows for bait was practiced to a limited extent in 1930, but has become big business only within the last 10 years. (4) The commercial production, in warm-water reservoirs, of fish for food was begun within the past few years in Arkansas and Mississippi using management methods based upon the research conducted by the Alabama Agricultural Experiment Station during the period 1948–54 (5) and on information obtained from other sources.

Germany and France have both practiced to a considerable extent rotations of 1 to 2 years in fish culture followed by 6 months to 1 year in grain crops. (6) Japan, Indonesia, and other Asiatic countries have developed a combination culture, raising both fish and rice simultaneously in the same fields. (7) This combined culture using rice and the common carp, has been found to increase materially the production of rice due to control of insect and weed pests. Also the combined culture has been found to increase the available nitrogen content of the soil apparently resulting from the activities of the carp. (8)

Fish farming has been reported to increase both the organic matter and the nitrogen content of soils. (3, 9) Both nitrogen-fixing bacteria and certain phytoplankton are reported to fix atmospheric nitrogen and thus add to the available nitrogen and organic matter in the bottom deposits of ponds. (10) Long continued flooding was found to deplete the calcium in soils in Alabama experiments (unpublished data) and thus make necessary periodic liming.

Various species of pond weeds and filamentous algae have been found to develop in shallow fishponds. (11) These interfere with fish production and may be detrimental to the rice crop which follows. Fertilization has been recommended for the control of various pond weeds (11, 12), but probably would be ineffective in shallow ricefield reservoirs.

Various chemicals have been recommended for reservoir weed control (13), but these may be detrimental to the rice crop that follows. Carp and a species of *Tilapia* being tested at the Alabama Agricultural Experiment Station show promise for possible biological control of certain obnoxious water weeds (unpublished data). Methods of weed control for a rice-fish rotation would appear best developed along biological lines.

Arkansas farmers engaging in commercial fish culture have already experienced losses due to parasites and disease introduced into their reservoirs from natural waters. Procedures have been developed for the control of many of these same species on trout (14), but little has been done on warm-water fishes. It will be necessary to adopt many of these methods for use in warm-water fish culture and to devise others. Since the chemical treatment of large ponds or reservoirs is prohibitive in cost, attention must be directed toward growing disease- and parasite-free fingerling fish for stocking, and to the exclusion of wild species.

PROCEDURES

1. Various species of fishes will be tested in ponds to determine the production per acre, resistance to disease and parasites, and their general desirability as commercial species for culture in Arkansas reservoirs. Among the species to be tested will be the bigmouth buffalo (*Megastomatobus cyprinella*), smallmouth buffalo (*Ictiobus niger*), the channel catfish (*Ictalurus punctatus*), selected strains of carp (*Cyprinus carpio*), the marble cat (*Ameriurus nebulosus marmoratus*), the brown cat (*A. Nebulosus*), the white cat (*I. catus*), and others. Minnows and largemouth bass (*Micropterus salmoides*) will be included in certain combinations.

2. For the more desirable species, methods of spawning and of raising the fry to fingerling size will be developed. This will include work on methods of overwintering and feeding the brood fish; methods of retarding spawning until danger of sudden cold weather is past; rates of stocking into brood reservoirs; use of fresh water for flooding brood reservoirs, and the injection of hormones to cause spawning; rates of stocking the fry into nursery reservoirs; and the use of fertilization and feeding to grow the fishes to a size suitable for stocking.

3. The use of dips of chemicals, reservoir treatments, feeding of antibiotics, and other measures to rid the brood fish and the fingerlings of parasites and diseases prior to stocking will be tested to develop reliable procedures. Among the treatments to be tested will be the use of formalin and potassium permanganate for external parasites, benzene hexachloride for anchor parasites and fish lice, kamala and dibutyl tin for intestinal parasites, antibiotics included in the food or injected into the brood fish for diseases, and similar treatments.

4. Tests will be conducted in reservoirs to devise methods of management for raising the fingerling fish to a marketable size. Experiments will include determination of the production obtained in flooded fields, with and without fertilization; the production obtained with crop residues left in the field following harvest of rice; the numbers of various species to be stocked to obtain various marketable sizes; methods of excluding wild fishes; the use of largemouth bass to control wild fish population; combinations of species giving maximum production per acre; the use of fish for mosquito control; feeding, and other related problems.

5. Tests will be conducted with fish-rice rotations of various lengths, including 1 year in fish—1 year in rice, 1 year in fish—2 years in rice, and 2 years in fish—2 years in rice. Also crops other than rice will be tried in the rotation. The production of fish will be compared with that in reservoirs producing successively yearly crops of fish to determine the effect of rice and other crops upon fish in the rotation. The production of rice will be compared with fields in continuous rice and in rice-fallowed field rotations. Records will also be kept upon the effect of the fish-rice rotation upon the organic matter, nitrogen, calcium, and pH of the soils; the amounts and kinds of obnoxious weeds in each crop; the prevalence of diseases and parasites of both fish and rice; and other related data.

6. Obnoxious weeds occurring in the fish-rice rotation will be noted and methods of their control developed. Tests will include the use of various chemicals such as sodium arsenite, copper sulfate, 2,4–D, and other hormone sprays. Where chemicals are used, their effect upon the fish crop and the rice crop will be determined.

7. Methods of harvesting the fish crop will be devised which can be used in shallow ricefield reservoirs. Trapping and netting will be tested as this will allow harvest of the fish over an extended period before draining. As many fishes swim into currents of fresh water, the use of water currents to draw fish into certain areas for netting will be tried. Electrical shocking will also be investigated for this purpose.

Various types of structures will be tested in ponds to determine those most suitable for concentration and removal of fish during draining operations.

Preparation of fish for marketing will also be studied, including those sold alive, those dressed and iced, and those dressed and frozen. Methods for handling and processing each of these groups will be devised for use by farmers.

Market outlets, methods of transportation, and market costs will be studied.

Use of the reservoirs for sport fishing will be studied.

General procedure—practices found to offer promise in the experimental reservoirs—will be tested at outlying points in cooperation with farmers.

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COST ESTIMATES

I. Initial expenditure for land and other capital needs

A. Land $60,000

Number of reservoirs	Size (acres)	Total acres
10	0.1	1.0
10	.25	2.5
10	.5	5.0
20	1.0	20.0
10	5.0	50.0
8	10.0	80.0
Other		[1] 41.5
Subtotal		200.0

[1] Area for general work, roads, canals, levees, and water storage.

B. Equipment, supplies, and buildings:

Estimated construction cost for reservoirs (including water lines and drains)	80,000
Wells and pumps	18,000
Laboratory, offices and equipment	30,000
Equipment shed	2,200
Fish tanks, holding facilities, and shed	4,500
4 boats	1,000
2 outboard motors	400
1 station wagon	2,500
2 trucks	5,000
Sprayers, planters, field equipment	4,500
Fertilizer and feed shed	1,500
Seines, nets, traps, cans, miscellaneous equipment	2,500
Surveying instruments	600
Subtotal	152,700
Total for initial expenditures	212,700

II. Annual cost

	Amount
A. Personnel:	
2 fisheries biologists at $7,500	$15,000
1 parasitologist or fisheries biologist with training in parasitology	7,500
1 agronomist	7,500
½-time marketing specialist	3,750
½-time engineer	3,750
½-time soils chemist	3,750
1 secretary	3,000
Subtotal	44,250
B. Yearly maintenance:	
Car and truck operation, repair, and replacement	3,000
Chemicals and disinfectants	500
Electricity (laboratory and pumps)	2,500
Weed-control chemicals	500
Fertilizers	2,500
Fish feeds	3,500
Field equipment	1,200
Field labor (7 men at $200 per month)	16,800
Fish traps and nets	300
Hardware supplies (tools, etc.)	350
Insurance on buildings and equipment	350
Laboratory equipment	1,000
Heating	500
Mimeograph and reprints	100
Office supplies	500
Outboard motor upkeep-replacement	100
Telephone and telegraph	600
Tractor rentals and operation	2,000
Travel	1,000
Miscellaneous	600
Subtotal	37,900
Total annual cost	82,150

Senator FULBRIGHT. Another article, by Mr. Joe Hogan, on the use of riceland for fish culture which I think would be informative.

Senator YARBOROUGH. It is so ordered.

(The document referred to follows:)

THE POSSIBILITIES OF MULTIPLE WATER USE IN ARKANSAS, WITH EMPHASIS ON RICELAND MANAGEMENT AND COMMERCIAL FISH FARMING

(By Joe Hogan)

INTRODUCTION

Water has always been an indispensable factor in agriculture and aquicultural practices. In the West it is referred to as the life's blood of the land. In Arkansas, over large areas of level land, water has become the life's blood of rice production and, thereby, limits the expansion of this industry. The passage of time sees underground water supplies being lowered a foot or more each year. On one hand every effort is made to ditch away surface water in order to expand farming lands and, on the other hand, lowered subsurface water levels are bringing problems to vast sections of riceland now in production.

As each year passes more ditches are opened and more lands drained. Drainage of submarginal lands, including natural lakes is not uncommon. Both private and Government funds have been poured into the mad drainage rush! In many instances we have already reached the point where the private individual farmer must obtain more water if he is to continue to till his land for rice.

The problems of water storage are being studied by engineers and reinjection of surface waters into subsurface strata is being considered. The subsurface

storage of water, however, lacks many of the advantages of surface storage in reservoirs, where additional food production can be carried on in the sunlight and known amounts of water can be held by an individual or corporation in a desired locality. This is another instance where the biology of stored waters must be considered by engineers, if maximum benefits are to be obtained. Many farmers, and especially rice farmers, are considering large reservoirs that may be alternately used for aquiculture by flooding and subsequently dried up for agriculture.

MULTIPLE RESERVOIR AND WATER USES

The shortage of subsurface waters has forced farmers to construct auxiliary reservoirs without too much consideration being given the many beneficial uses other than irrigating rice. As time passes, experience is gained and we have learned that impoundments have multiple uses including the following:

1. Irrigation:
   - Rice fields.
   - Dry-land crops.
2. Fish production:
   - Gamefish species.
   - Commercial food fishes.
   - Commercial nonfood fishes for processing.
   - Bait and forage fishes.
   - Combination game and commercial fishes.
3. Clearing of timberland.
4. Waterfowl habitat:
   - Shooting areas.
   - Resting and feeding areas.
5. Livestock watering.
6. Crop rotation:
   - Wet-land farming (aquiculture).
   - Dry-land farming (agriculture).
7. Increase land fertility.
8. Vegetation control:
   - Flooding to kill dry-land weeds.
   - Drying to control aquatic plants.
9. Retention of a given amount of water in canals and drainage ditches for elimination of willows, etc.
10. Surface water supply properties:
    - Quality, superior to underground waters.
    - Quantity, ample.
    - Subsurface supply conserved.
11. Retention of surface water as an aid in flood control.
12. Recreation:
    - Swimming.
    - Boating.
    - Fishing.

DISCUSSION

The cost of supplying underground water for irrigation is high, and deep wells require special drilling equipment, pumps with large motors, and are expensive to install and operate. In some localities the lift in wells has become so great as to make irrigation impossible if not impracticable. Reservoirs are the answer to the problem. Ordinary dirt moving equipment can be used to build the levees and the cost need not be all charged to irrigation, or even to any single use. A breakdown of the original cost of construction and operation of a reservoir might be charged off as follows: Irrigation 35 percent; fish production 25 percent; clearing of land 10 percent; waterfowl benefits 2 percent; livestock watering 2 percent; crop rotation benefits 6 percent; increased fertility 2 percent; vegetation control 2 percent; water quality improvement 5 percent; flood prevention 1 percent; and recreation 10 percent. Proper planning for multiple use cannot be overemphasized.

Irrigation

The production of rice through irrigation is a major industry in the level lands of the State. The expansion of rice farming has spread to many areas where soils and water are suitable. The original rice fields were in the Stuttgart-Lonoke sections, where the underground water supplies are being lowered a foot or more each year. Artificial earthen reservoirs have been constructed for im-

poundment of irrigation waters and are considered to be the answer to the water supply problem. Both rice and dry-land farmers are interested in water for their crops.

Fish production

Fish production has developed in a very haphazardous manner with most attention being given the gamefish species. Bass, bream, and crappie were planted in the waters or gained entrance through water pumped or drained into the reservoirs. Gamefish introduced into new waters grow and expand. In many instances fishing clubs have leased the waters or individual fishermen have paid for the privilege of a day's fishing. Several farmers having two or more reservoirs follow this plan and water depths are maintained so as to sustain fish life at all times of the year. Gamefish cannot be sold. Harvest of these species depends upon sport fishing. Since 2 years or more are necessary for the growth of large gamefish a detailed plan of operations must be formulated for the stocking, growing, harvesting, sorting and restocking of the fish. The details of management for gamefish species are fairly well understood and experienced fish culturists are available for advice and consultation.

Commercial fish farming is being considered by farmers so as to have a complementary cash crop from the reservoirs. The propagation of buffalo fish, catfish, drum, and similar commercial species is being seriously undertaken. Yearly production has been estimated at from 1,000 to 10,000 pounds per acre, presumably with a supplemental feeding program. The fish crop to be raised is divided into two groups: fish for human consumption and fish for processing into fish meals, fish oils, dog food and similar products.

The problems of propagating catfish and buffalo fish have been worked out by a limited number of experienced fish culturists, however, additional information is needed for the growing of these species to commercial sizes for human consumption. At least 2 years or longer will be required to grow an edible fish and supplemental feeding may be necessary to speed the growth rate. The propagation of drum has not been undertaken in artificially impounded waters and experimental research is needed before large areas or moneys are invested in drum production. Since the gizzard shad is a plankton feeder and a desirable forage fish for cannibalistic gamefish, serious thought should be given to the production of shad as bass food and for processing into fish meals.

Bait fish are in demand all during the year and reservoirs could be devoted wholly to propagating shiners and other common bait species. At the present time, several commercial minnow growers are operating in Arkansas. Bait minnows are sold by the thousands to fishermen, and the price per pound is much higher than can be expected from food or fish processing markets. Where ponds are devoted to minnow production one must have complete control of the water supply and the ponds will need draining once or twice a year. This may complicate their operation in conjunction with surface reservoirs, but with proper planning and management it could be done. The successful operation of water areas for bait-minnow production will call for many hours of labor, and persons entering this phase of reservoir management should realize in advance the time and expense necessary for carrying a crop of minnows through from early spring to summer and fall before they are salable as bait. Many days of training in handling, feeding, sorting, shipping, stocking, and the treatment for parasites is necessary before suitable minnows can be placed on the market in satisfactory physical condition.

Some farmers may desire to utilize their reservoir as producers of both commercial and sports fish. This will call for a combination of the 2 separate plans into 1 coordinated type of reservoir operation. There is some doubt, however, that an attempt of this sort will produce maximum yields. In early spring a 6-inch bass can eat a young buffalo fish that would weigh 6 pounds by the following winter. Small sunfish are also predatory and during the spawning season will eat the eggs of buffalo fish and other species of a similar nature that spawn in shallow, vegetated-water areas. Thus the game species might hold in check the commercial fish and reduce the total pounds of salable fish that might be grown per acre. Knowledge of proper design must receive attention, including levee construction, reservoir drainage, stocking, and water supply, when fish are to be grown and successfully harvested in a body of water.

Clearing of timberland

The clearing of timberland is slow and costly when done in the customary way. But in the flatlands of Arkansas, large acreages of timberland can be leveed around and flooded. Thus a reservoir is formed and at the same time

the woods will be killed. In 3 or 4 years the reservoir can be dried up and burnt off clean. The area can then be planted in rice. For convenience in farming, reservoirs should cover at least 40 acres of land, and can include much larger tracts if lands are available. Level, fertile land, not the poorest on the farm, should be placed in the reservoir if maximum fish production is desired. Fish will, like all ordinary crops, reflect the fertility of the soils on which they are grown.

Waterfowl habitat

Waterfowl migrate to Arkansas' lowlands in the fall and winter, spending several months in the State. These birds are incubated and grown in the marshes of the North and come South to the lowlands for the winter. Artificial earthen reservoirs attract thousands of ducks. By setting up resting and feeding grounds and hunting zones, the local hunters can take a share of the birds while leaving stocks for posterity. Hunting privileges are sold by many reservoir owners. Others allow shooting by their friends and members of the community. Special water-level management must be given reservoirs for migratory waterfowl, since live timber is needed to supply food. Ducks will not be attracted to waters that do not provide food and shelter.

Livestock watering

Reservoirs are ideal as a source of water for livestock. Thousands of reservoirs have a pipe through the levee with a tank and float valve for this purpose. The average farm reservoir supplies all the water needed for the herd and eliminates a heavy drain on the farm well.

Crop rotation

Crop rotation is necessary in rice farming. As a general rule, 2 or possibly 3 rice crops can be grown before the land must be changed to another crop or, as is usually the case, left idle for a period. By having suitable levees around the field it can be alternated from agriculture to aquiculture, thus producing a crop every year. After a crop of commercial fish is grown, the field can be drained, fish removed, and the land again placed in rice production. There is even some evidence that the soil will be improved in structure and fertility. The flooding of organic matter resulting from agricultural use facilitates decomposition adding humus to the soil. The release of bound nutrient compounds in the soil is brought about by drainage and cultivation of the area. Newly impounded waters will usually produce large crops of fish. As time passes, the fertility of the lake becomes locked in the bottom muck and smaller fish crops are grown. The alternate drying and flooding of the reservoir for rice and fish production will more fully utilize the mineral elements present and the farmer should plan his fields to grow a crop of fish and then rotate with 2 or 3 crops of rice. Fertilizers used to promote fish growth in the reservoir eventually are fully utilized in three ways: (1) Increased fish production, (2) increased production in crops irrigated by the reservoir water, and (3) increased yields of crops from the reservoir after it is drained and placed in cultivation.

Vegetation control

The control of vegetation might necessitate the deep flooding of a field to kill wild rice and coffee beans which harass the farmer, or it could mean the drying out of a reservoir to kill submerged and emergent aquatic plants that will choke shallow lakes and prevent satisfactory fish crops. Both types of plants must be eliminated, and the most expedient manner of control is to change the fundamental habitat from wet to dry or vice versa. Farmers with 2 or more reservoirs can folow this plan, while those with only 1 reservoir are at a disadvantage and must resort to chemicals or other control measures. Turbid water from plowed fields will tend to check aquatic plant growths in reservoirs.

Canals and drainage ditches should be equipped with gates for alternate flooding and drying in order to control weeds and willows that will soon crowd the bank and retard waterflow. The same ideas for plant control in reservoirs should be applied to the connecting canals and ditches.

Water quality and quantity

According to the experience of the farmers in the Stuttgart area, surface water is generally superior to subsurface water for rice irrigation. Fields receiving surface water need not be rotated in dryland leguminous crops as often as fields irrigated from wells.

The quantity of surface water for irrigation is ample if plans are made to collect it during rainy periods. In the Rice Belt of Arkansas an average of about 48 inches of rain falls in a year.

This amount, plus the drainage from the watershed above, that can be collected and relifted into the reservoir, should be sufficient. The location of the reservoir adjacent to natural watercourses is important so as to insure ample water for both fish life and irrigation purposes. The increasing number of surface reservoirs will relieve the underground supply, thereby permitting the natural recharge of the water-bearing strata for farmers who depend upon wells.

Flood control

The retention of surface waters in reservoirs during storm periods will assist, in a small measure, in flood control. Farmers should plan to fill the reservoirs and prevent the downstream passage of surface waters at a time when the water is not needed in the public streams. The amount of water caught in reservoirs at the present time is small, but, as time passes, more reservoirs will be built and the effects will be more in evidence.

Recreation

Swimming, boating, and hook-and-line fishing are to be found in all reservoirs after they are filled and are producing fish. No pastime is better for the rural youngsters than a dip in the water and a boat and line for fishing. The fishing rights, if properly attended and developed, can be sold to an organized club or as daily permits to fishermen. It is not unusual for a large reservoir to collect from $30 to $50 a day for fishing privileges during summer holidays.

CONCLUSIONS

The 12 major topics just listed will serve to illustrate the many advantages of large size artificial reservoirs on rice farms. Truly water is a most important tool in land management. Multiple reservoir use can bring to the bona fide farmer several benefits, but they require special talent and attention to develop. A productive reservoir must receive attention, including hard work, just the same as any other enterprise, namely, rice farming. Some of the problems will be easily solved and some may eventually be worked out after the reservoir is flooded and placed in operation. The ideal rice farm should have two or more separate resersoirs in orders to permit the retention of gamefish and the transfer of commercial species not ready for market.

The following quotation is taken from a division of fish culture report delivered by the author before the American Fisheries Society in 1938 at Ashville, N. C. "The Nation is becoming waterwise. The era of drainage at any price has about run its course, and water conservation on a large scale is being planned. On our major watersheds large reservoirs are being planned and built in order to combat floods. If all these plans are carried out, within the next few years millions of dollars will be spent in an attempt to regulate the flow of water in many sections of the country. Water reservoirs are being built by cities, corporations, and individuals. No park or recreation area is complete a lake, either natural or artificial. Public officials, machinery companies, construction companies, engineers, contractors, farmers, and laborers, and many other citizens who in the past did not have a sympathetic attitude toward water conservation and fisheries problems are directly interested in this movement. Water is being conserved for navigation, irrigation, flood control, drought control, hydroelectric plants, various industrial purposes, municipal water supply, boating, bathing, fishing, shooting marshes and many other purposes."

Without a doubt reservoirs built by our farmers will play an important roll in our economy when all the beneficial factors are properly developed.

Senator FULBRIGHT. The idea of raising fish on farm acreage is not new. For centuries fish have been propagated in Europe and Asia as a part of normal farming operations. It has been estimated that the Chinese began fish culture on farmland as long ago as 2100 B. C. In spite of the widespread practice of fish-rice culture in foreign countries, the idea had not generated much interest among our rice farmers until the last few years. Fish farming in this country was pioneered in Arkansas and farmers of my State have continued to hold the lead in developing its potential.

Arkansas rice farmers became interested in fish farming almost by accident. In bringing new rice acreage into production it is customary to build levees around a tract of land, filling the resulting reservoir with water and letting it stand for a couple of years until the timber dies and the decayed vegetation has enriched the soil. Following this procedure farmers soon found that the water in the reservoirs always contained abundant supplies of the local species of fish.

Some farmers began selling rights on their reservoirs for sport fishing but, on draining the reservoir for cultivation, there were still tons of edible fish left regardless of how much fishing there had been in the reservoir. Additional experimentation by farmers resulted in the determination that production of fish in the reservoirs greatly increased the fertility of the soil, causing a marked increase in production of soil-grown crops. This knowledge led eventually to the beginning of commercial production of fish for food in rotation with rice and other crops.

In rice culture it is customary to fallow or grow other crops on the land after 2 or more years of rice production in order to control certain weeds and other pests and rebuild soil fertility. The land remains in a lower-then-rice-return-use for 1 or 2 years. It is this period that farmers use for the commercial production of fish.

There are now about 300 fish farmers in Arkansas who farm an estimated 60,000 acres—there is more than that, I think there has been a substantial increase recently—producing fish of various kinds. The average yield is about 500 pounds of fish per acre per year, depending to some extent on the species of fish being raised.

The fish farming industry is developing rapidly in Arkansas and a special organization, the Arkansas Fish Farm Cooperative at Lonoke, Ark., has been established to handle some of the problems encountered. A representative of the cooperative is here today and I am sure he will be able to supply the committee members with the more technical details of fish farming if the members so desire.

Arkansas fish farmers have found that there are many advantages to commercial production of fish on idle acreage. One of the foremost, of course, is the increased income which results when the land is put to more profitable use. To date, farmers have found ready sales for their fish through the local markets, but as production increases new knowledge of marketing methods will be necessary.

I might mention at this point that Arkansas has worked out a solution in the marketing of game fish produced on fish farms which protects the system for enforcement of the State's game fishing regulations.

The Arkansas State Legislature unanimously adopted a bill this year which establishes a registration system for fish farmers and provides for a positive system of marketing game fish commercially produced on fish farms. Other States which have some concern that fish farming and marketing of game fish commercially produced will interfere with enforcement of fishing laws and regulations might follow the lead of Arkansas in this respect. That is the document that I mentioned a moment ago to be inserted in the record.

Another substantial benefit to farmers from fish culture on flooded acreage is the increase in soil fertility brought about by letting water stand on the land for a length of time. This increases both nitrogen

and organic matter in the soil, which results in increased crop yields when the land is returned to normal farm production.

There are many other benefits from fish-rice rotation which I shall list but about which I shall not go into in detail. Fish farming helps prevent piling up additional farm surpluses by taking out of porduction land devoted to producing commodities now in oversupply; is covered by both the acreage reserve and the conservation reserve features of the soil-bank program; reservoirs make natural waterfowl habitats, and farmers can sell hunting privileges; reservoirs can be used for watering livestock; controls certain weeds and insects; conserves water supplies; reservoirs can assist in flood control by utilizing them as reserve reservoirs in high-water periods; they can provide recreation such as swimming, boating, and fishing.

I would like to explain briefly what S. 1552 would accomplish. The bill authorizes the Secretary of Agriculture to contract with the University of Arkansas for the establishment of an experiment station to conduct research into various aspects of fish-rice production.

The research objectives are stated in the bill and are the result of much discussion and study by the university officials and fish-farming interests.

The university attempted to obtain funds through the Saltonstall-Kennedy program on two occasions last year to establish such a research project, but the Fish and Wildlife Service turned them down both times with the explanation that the proposal was not high enough on their priority list to put any money into it at that time.

Because of this I felt the only solution was legislation to authorize the project. The bill allows the Secretary of Agriculture to cooperate with the Fish and Wildlife Service as well as with State and local agencies. Since it was felt that this problem is primarily agricultural rather than biological, it specfies that the primary responsibility for the project will be with the Department of Agriculture rather than the Department of the Interior.

As drafted, the bill would allow the program to be carried out as part of the experiment station operations now conducted by the Department of Agriculture and the University of Arkansas. We have a fine rice experiment program in operation in Arkansas now and this project would fit in well with the work already being conducted.

I want to emphasize, however, that my primary concern is in getting the project authorized and the question of who administers it is purely secondary. I might reiterate that—I have no dogmatic ideas about who can do this—we are interested in whoever is willing and able to do it, and I think either Interior or Agriculture are able to do it. Interior, heretofore, as I have indicated, did not evidence great interest in it, but if they feel that they are willing to proceed with this and to endorse the legislation, as I understand their report which we just received this morning indicates, then I have no objection at all to that procedure.

The cost estimates for conducting a project similar to this, as developed during the previous application for funds under the Saltonstall-Kennedy Act were $212,700 initial or capital expenditures and $82,150 annual cost. This is a very small sum when contrasted to the benefits which will be derived from the added knowledge achieved through the research program authorized by the bill.

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The field of fish farming is developing rapidly but the main handicap to the industry is the lack of adequate research information. The bulk of all fishery research work in this last 20 years has been on sport fish, with very little emphasis on commercial fish other than salt-water varieties.

The only research project on warm-water fish in the country is being conducted by the University of Oklahoma under a Saltonstall-Kennedy grant. The project deals with research on the artificial spawning of channel catfish. Some work has been done at Alabama Polytechnic Institute on fresh-water fish.

There is a real need for Federal attention to this problem. It is impossible for private interests to conduct the necessary research work alone. The private farmers have uncovered the potential of fish farming and it is now up to the Federal Government to insure that the program proceeds in the right direction.

The research project covered by S. 1552 would benefit not only my State but ultimately every section of the country. The information developed through the project could be made applicable to all rice-growing areas. The rotation of fish culture with rice production has tremendous possibilities for all rice farmers.

It is possible that much of the data developed would also be useful for encouraging fish culture in relation with crops other than rice. There is no doubt that much information on game fish which will be discovered through this project will be applicable throughout the country to sports fishing.

By finding out more about a profitable way for taking land out of production we will also aid in reducing agricultural surpluses. This is one case where the expenditure of a small sum for research will undoubtedly pay for itself many times by helping in one way to solve our farm problem.

I hope the subcommittee will carefully consider the many possibilities of this proposal. I have already supplied the committee with two documents to be inserted.

That finishes my prepared statement.

Mr. Chairman, I have two distinguished citizens of my State, Mr. Roy Prewitt, who is here with me, and Dr. John White, who are prepared to make further statements of a more technical and I am sure more valuable nature than I have given you. I would like to introduce them to the chairman.

Does the chairman desire to ask me any questions?

Senator YARBOROUGH. Does the staff have any questions?

Mr. BAYNTON. No questions.

Senator YARBOROUGH. I only desire to thank the distinguished Senator from Arkansas for this statement and say in the brief period that I served in the occupation of Japan—some 9 months—I saw this type of fish culture there without the opportunity for scientific investigation and became very much interested in it, and I want to congratulate the Senator for introducing this measure and for the interest and leadership he has shown in what I think is a needed step.

Senator FULBRIGHT. I appreciate that very much. I am delighted to have such a sympathetic chairman hearing the testimony on this legislation.

I would like to introduce Mr. Roy Prewitt. He is one of our leading fish farmers in Arkansas and a leading citizen of our State, and

Dr. John White of the university. They will be able to give you practical details, which I am sure the committee will be interested in, much better than I can.

Senator YARBOROUGH. Thank you, Senator Fulbright, for being here.

Which one of you gentlemen desires to be heard first?

Senator FULBRIGHT. This is Dr. White, Mr. Chairman.

STATEMENT OF DR. JOHN W. WHITE, ASSOCIATE DIRECTOR OF THE ARKANSAS AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF ARKANSAS

Mr. WHITE. Mr. Chairman, I have a very short statement which I could either ad lib or read, and then some material I would like to leave with the committee for insertion in the record if you see fit.

Senator YARBOROUGH. Take whichever way you desire to present it.

Mr. WHITE. I will read it, if I may.

Senator YARBOROUGH. You may be seated.

Mr. WHITE. My name is John W. White. I am associate director of the Arkansas experiment station. I am in direct charge of the agricultural research program of the experiment station which is an administrative unit of the University of Arkansas, a land-grant institution. I have been authorized to speak for the university and its experiment station by the board of trustees of the institution.

Our board of trustees, and in turn its various administrative officers and research workers, are very much interested in the proposed fish farming experiment station for three reasons: (1) A lack of knowledge exists on the question; (2) a satisfactory program of production will be of material assistance to both producers and consumers; (3) since fish farming operations in Arkansas are closely tied in with rice farming, and since we have a long record of experience in rice research, we feel that the university can make a contribution to the problem.

The commercial production of fish for food in ponds or reservoirs is an ancient practice and has been followed extensively in the Far East and in Europe. Some information is also available regarding various types of fish production in the United States. However, the production of fish in rotation with rice is a new practice in the United States and information regarding this problem is limited to data available from other types of fish production and from observation.

Obviously, a large-scale production of fish on rice farms involves a considerable investment and offers a high potential for improvement in the production of rice and fish. Both rice and fish are important sources of food to the entire world.

The production of fish in rotation with rice is a unique innovation in American agriculture. If satisfactory practices are carried out in this type of production both producers and consumers will benefit. Producers will benefit from improved soil and water conservation. Soil productivity will be increased. Undesirable weeds can be controlled. Water may be stored during wet seasons for use during periods of less plentiful supply. Consumers will benefit from a more plentiful and cheaper food supply.

The Arkansas experiment station has been engaged in successful research related to rice farming for a number of years. We are

proud of our accomplishments in this connection. Also, the University of Arkansas is in position to contribute to the training of personnel who in turn can do a better job of both rice and fish production. Our agricultural extension service is in position to receive new information obtained from research and immediately get this information into use of producers. Thus we feel that the university is in a unique position to contribute to a solution to the problem and it stands ready to do so in any way possible.

The university urges the Congress to give consideration to the problem of making more information available on a question which we feel is of importance not only to producers but to consumers of food commodities.

I should like to leave with the committee a copy of the resolution passed by our board of trustees in support of Senate bill 1552 and a copy of a research project which we developed as a basis for initiating work on a commercial production of fish in ricefield rotation and as a separate crop.

Also, I should like to leave with the committee a copy of the statement outlining the contributions which the university might make to this problem.

Thank you.

(The documents referred to follow:)

RESOLUTION ADOPTED BY BOARD OF TRUSTEES, UNIVERSITY OF ARKANSAS, JUNE 29, 1957

Moved and carried that the board endorse the provisions of S. 1552 now before Congress and offer full support and cooperation in carrying out the purposes of the proposed legislation.

T. C. CARLSON, *Secretary.*

A PROPOSED FISH-RICE RESEARCH PROJECT[1]

Title: Commercial production of fish in ricefield rotations and as a separate crop.

OBJECTIVES

1. To determine species of fishes most suitable for culture on a commercial basis in shallow reservoirs and flooded ricelands in Arkansas.
2. To determine methods for production of fingerling fishes for stocking in commercial reservoirs.
3. To develop methods for the control of parasites and diseases of brood fishes and of fingerlings prior to stocking.
4. To develop economical methods for raising the more desirable species of fishes to a marketable size.
5. To determine the effects of fish-rice rotations, including crops other than rice commonly grown on rice farms, upon both the fish and other crops.
6. To develop methods for the control of obnoxious weeds developing in the fish-rice rotation.
7. To develop suitable methods for harvesting the fish crop and preparing it for marketing. Sport fishing will be studied as a means of harvest and use of the facility.

REASONS FOR UNDERTAKING THE WORK

Arkansas is especially favored in respect to both water supplies and productive soils. As a result, rice culture has developed extensively in the eastern half of the State. In rice culture it is customary to fallow or grow other crops on the land after 2 or more years in rice for the control of certain weeds

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[1] Developed for the University of Arkansas Agricultural Experiment Station by H. S. Swingle of the Alabama Agricultural Experiment Station, and modified by the staff of the Arkansas station and by the board of directors of the Arkansas Fish Farmers' Cooperative.

and other pests. These fields remain in a lower than rice return use for 1 to 2 or more years. It appears possible to use these fields during this fallowing or rotation period for fish production and thus develop a rice-fish or rice-fish and other crop rotation. Such a rotation should increase the income of Arkansas rice farmers by putting the land to a higher return use.

In addition many acres formerly in rice have been retired because of restrictive quotas. Fish-farming would appear to offer a profitable use of much of this land.

For the above reasons, many Arkansas farmers have become interested in raising fish as a crop and a large acreage is now being used for this purpose. Research is greatly needed upon this new agricultural industry in Arkansas to provide farmers with the information necessary to make fish farming a success in the State. (1)

PREVIOUS WORK AND PRESENT OUTLOOK

The commercial production of fish for food in ponds or reservoirs is an ancient practice. Records as early as 500 B. C. refer to it as a common practice in China (2) and by the year 1358 it was an established industry in Europe. (3) Fish farming is at present an important industry in the following foreign countries: Germany, Poland, Czechoslovakia, France, China, India, Philippines, Japan, and Indonesia.

In the United States, the commercial production of trout in raceway is a profitable type of fish culture which has been practiced extensively for over 50 years. The commercial production in ponds of minnows for bait was practiced to a limited extent in 1930, but has become big business only within the 10 years.

(4) The commercial production, in warm-water reservoirs, of fish for food was begun within the past few years in Arkansas and Mississippi using management methods based upon the research conducted by the Alabama Agricultural Experiment Station during the period 1948–54 (5) and on information obtained from other sources.

Germany and France have both practiced to a considerable extent rotations of 1 to 2 years in fish culture followed by 6 months to 1 year in grain crops. (6) Japan, Indonesia, and other Asiatic countries have developed a combination culture, raising both fish and rice simultaneously in the same fields. (7) This combined culture using rice and the common carp, has been found to increase materially the production of rice due to control of insect and weed pests. Also the combined culture has been found to increase the available nitrogen content of the soil apparently resulting from the activities of the carp. (8)

Fish farming has been reported to increase both the organic matter and the nitrogen content of soils. (3, 9) Both nitrogen-fixing bacteria and certain phytoplankton are reported to fix atmospheric nitrogen and thus add to the available nitrogen and organic matter in the bottom deposits of ponds. (10) Long-continued flooding was found to deplete the calcium in soils in Alabama experiments (unpublished data) and thus make necessary periodic liming.

Various species of pond weeds and filamentous algae have been found to develop in shallow fishponds. (11) These interfere with fish production and may be detrimental to the rice crop which follows. Fertilization has been recommended for the control of various pondweeds (11, 12), but probably would be ineffective in shallow ricefield reservoirs.

Various chemicals have been recommended for reservoir weed control (13), but these may be detrimental to the rice crop that follows. Carp and a species of *Tilapia* being tested at the Alabama Agricultural Experiment Station show promise for possible biological control of certain obnoxious water weeds (unpublished data). Methods of weed control for a rice-fish rotation would appear best developed along biological lines.

Arkansas farmers engaging in commercial fish culture have already experienced losses due to parasites and disease introduced into their reservoirs from natural waters. Procedures have developed for the control of many of these same species on trout (14), but little has been done upon warm-water fishes. It will be necessary to adopt many of those methods for use in warm-water fish culture and to devise others. Since the chemical treatment of large ponds or reservoirs is prohibitive in cost, attention must be directed toward growing disease- and parasite-free fingerling fish for stocking, and to the exclusion of wild species.

PROCEDURES

1. Various species of fishes will be tested in ponds to determine the production per acre, resistance to disease and parasites, and their general desirability as commercial species for culture in Arkansas reservoirs. Among the species to be tested will be the bigmouth buffalo (*Megastomatobus cyprinella*), smallmouth buffalo (*Ictiobus niger*), the channel catfish (*Ictalurus punctatus*), selected strains of carp (*Cyprinus carpio*), the marble cat (*Ameriurus nebulosus marmoratus*), the brown cat (*A. nebulosus*), the white cat (*I. catus*), and others. Minnows and largemouth bass (*Micropterus salmoides*) will be included in certain combinations.

2. For the more desirable species, methods of spawning and of raising the fry to fingerling size will be developed. This will include work on methods of overwintering and feeding the brood fish; methods of retarding spawning until danger of sudden cold weather is past; rates of stocking into brood reservoirs; use of fresh water for flooding brood reservoirs, and the injection of hormones to cause spawning; rates of stocking the fry into nursery reservoirs; and the use of fertilization and feeding to grow the fishes to a size suitable for stocking.

3. The use of dips of chemicals, reservoir treatments, feeding of antibiotics, and other measures to rid the brood fish and the fingerlings of parasites and diseases prior to stocking will be tested to develop reliable procedures. Among the treatments to be tested will be the use of formalin and potassium permanganate for external parasites, benzene hexachloride for anchor parasites and fish lice, kamala and dibutyl tin for intestinal parasites, antibiotics included in the feed or injected into the brood fish for diseases, and similar treatments.

4. Tests will be conducted in reservoirs to devise methods of management for raising the fingerling fish to a marketable size. Experiments will include determination of the production obtained in flooded fields, with and without fertilization; the production obtained with crop residues left in the field following harvest of rice; the numbers of various species to be stocked to obtain various marketable sizes; methods of excluding wild fishes; the use of largemouth bass to control wild-fish population; combinations of species giving maximum production per acre; the use of fish for mosquito control; feeding, and other related problems.

5. Tests will be conducted with fish-rice rotations of various lengths, including 1 year in fish—1 year in rice, 1 year in fish—2 years in rice, and 2 years in fish—2 years in rice. Also crops other than rice will be tried in the rotation. The production of fish will be compared with that in reservoirs producing successive yearly crops of fish to determine the effect of rice and other crops upon fish in the rotation. The production of rice will be compared with fields in continuous rice and in rice-fallowed field rotations. Records will also be kept upon the effect of the fish-rice rotation upon the organic matter, nitrogen, calcium, and pH of the soils; the amounts and kinds of obnoxious weeds in each crop; the prevalence of diseases and parasites of both fish and rice; and other related data.

6. Obnoxious weeds occurring in the fish-rice rotation will be noted and methods of their control developed. Tests will include the use of various chemicals such as sodium arsenite, copper sulfate, 2,4-D, and other hormone sprays. Where chemicals are used, their effect upon the fish crop and the rice crop will be determined.

7. Methods of harvesting the fish crop will be devised which can be used in shallow ricefield reservoirs. Trapping and netting will be tested as this will allow harvest of the fish over an extended period before draining. As many fishes swim into currents of fresh water, the use of water currents to draw fish into certain areas for netting will be tried. Electrical shocking will also be investigated for this purpose.

Various types of structures will be tested in ponds to determine those most suitable for concentration and removal of fish during draining operations.

Preparation of fish for marketing will also be studied, including those sold alive, those dressed and iced, and those dressed and frozen. Methods for handling and processing each of these groups will be devised for use by farmers.

Market outlets, methods of transportation, and market costs will be studied.

Use of the reservoirs for sport fishing will be studied.

General of procedure—practices found to offer promise in the experimental reservoirs—will be tested at outlying points in cooperation with farmers.

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COST ESTIMATES

I. Initial expenditure for land and other capital needs

A. Land $60,000

Number of reservoirs	Size (acres)	Total acres
10	0.1	1.0
10	.25	2.5
10	.5	5.0
20	1.0	20.0
10	5.0	50.0
8	10.0	80.0
Other		[1] 41.5
Subtotal		200.0

[1] Area for general work, roads, canals, levees, and water storage.

B. Equipment, supplies, and buildings:

Estimated construction cost for reservoirs (including water lines and drains)		$80,000
Wells and pumps	$18,000	
Laboratory, offices and equipment	30,000	
Equipment shed	2,200	
Fish tanks, holding facilities, and shed	4,500	
4 boats	1,000	
2 outboard motors	400	
1 station wagon	2,500	
2 trucks	5,000	
Sprayers, planters, field equipment	4,500	
Fertilizer and feed shed	1,500	
Seines, nets, traps, cans, miscellaneous equipment	2,500	
Surveying instruments	600	
Subtotal	152,700	
Total for initial expenditures		212,700

II. Annual cost

	Amount
A. Personnel:	
2 fisheries biologists at $7,500	$15,000
1 parasitologist or fisheries biologist with training in parasitology	7,500
1 agronomist	7,500
½-time marketing specialist	3,750
½-time engineer	3,750
½-time soils chemist	3,750
1 secretary	3,000
Subtotal	44,250
B. Yearly maintenance:	
Car and truck operation, repair, and replacement	3,000
Chemicals and disinfectants	500
Electricity (laboratory and pumps)	2,500
Weed control chemicals	500
Fertilizers	2,500
Fish feeds	3,500
Field equipment	1,200
Field labor (7 men at $200 per month)	16,800
Fish traps and nets	300
Hardware supplies (tools, etc.)	350
Insurance on buildings and equipment	350
Laboratory equipment	1,000
Heating	500
Mimeograph and reprints	100
Office supplies	500
Outboard motor upkeep-replacement	100
Telephone and telegraph	600
Tractor rentals and operation	2,000
Travel	1,000
Miscellaneous	600
Subtotal	37,900
Total annual cost	82,150

BRIEF OUTLINE OF TALK GIVEN BY JOHN W. WHITE, ASSOCIATE DIRECTOR, AGRICULTURAL EXPERIMENT STATION, AT THE FIRST ANNUAL MEETING OF THE ARKANSAS FISH FARMERS' COOPERATIVE, MARION HOTEL, LITTLE ROCK, ARK., JANUARY 29, 1957

Topic: The role of the university in Arkansas fish culture.

The University of Arkansas has a three-way role to perform in relations to fish culture. These roles are:

(1) Basic instruction in zoology on fish biology;

(2) Work by extension people in taking information to Arkansas farmers in regard to fish production, handling, and marketing;

(3) Research on the problem of fish production and handling on Arkansas farms. Also, research on the marketing of fish produced.

The department of zoology at the university is doing some work on teaching in relation to fish. This is pretty much the usual type of basic work found in zoology at land-grant institutions or State universities. Agricultural Extension Service personnel are working to bring any educational information available to them to the attention of farmers interested in fish culture. At present, the agricultural experiment station is carrying on a very small project relating specifically to fish production in Arkansas reservoirs. Soil samples are being collected from 12 reservoirs and an analysis is being made from these samples to determine the effects on the soil of fish production in the reservoirs.

The board of directors of the Arkansas Fish Farmers' Cooperative, as well as certain individual members, have for some time discussed with university officials the possibilities of the agricultural experiment station conducting a rather comprehensive research program on rice-fish rotations. They have suggested that the work be tied in with existing work on rice and rice-farm problems now underway at the rice branch experiment station.

When the university was first approached as to the possibilities of securing financial assistance for a rice-fish research project from Saltonstall-Kennedy funds a very modest request, approximately $15,000, was submitted to the Department of Interior for approval. Prior to action on this project it became apparent that the project would be inadequate to do the work desired by the cooperative. Therefore, in line with suggestions from the board of directors of the cooperative the original project was supplemented by an additional $35,000 request making a total request of $50,000. This request was not approved by the advisory committee for Saltonstall-Kennedy funds.

Conferences between various people, members of the board of the Arkansas Fish Farmers' Cooperative, and university officials indicated that we should continueto work for some source of support for a rice-fish project.

In view of the conditions outlined above and the definite need for research information on problems of fish production in connection with rice farming, university officials enlisted the advice, counsel, and aid of Prof. H. S. Swingle of the Alabama Agricultural Experiment Station as a consultant on the project. Professor Swingle prepared a very complete project on rice-fish rotation studies. This request was modified to some extent by the staff members of the Arkansas Agricultural Experiment Station. After a review and thorough consideration by the board of directors of the Arkansas Fish Farmers' Cooperative, the project was slightly modified in relation to objectives, costs, and other needs for doing the job. Thus, throguh a cooperative effort, we developed what we think is a very thorough and comprehensive project with the following title and objectives:

Title: Commercial Production of Fish in Rice-Field Rotations and as a Separate Crop.

OBJECTIVES

1. To determine species of fishes most suitable for culture on a commercial basis in shallow reservoirs and flooded ricelands in Arkansas.
2. To determine methods for production of fingerling fishes for stocking in commercial reservoirs.
3. To develop methods for the control of parasites and diseases of brood fishes and of fingerlings prior to stocking.
4. To develop economical methods for raising the more desirable species of fishes to a marketable size.
5. To determine the effects of fish-rice rotations, including crops other than rice commonly grown on rice farms, upon both the fish and other crops.
6. To develop methods for the control of obnoxious weeds developing in the fish-rice rotation.
7. To develop suitable methods for harvesting the fish crop and preparing it for marketing. Sport fishing will be studied as a means of harvest and use of the facility.

Cost estimates developed in consultation with the board of directors of the Arkansas Fish Farmers' Cooperative indicate that to do anything like a reasonable job with the project, an initial investment of $212,700 would be needed to acquire land, equipment, and other items to start the project. The annual cost of operating the project is estimated at $82,150. Officials of the Department of Interior indicated that the advisory committee did not recommend the project for immediate approval; rather, action has been delayed on the project and it is now in the active file of the Department of Interior.

Since definite and immediate approval was not secured on the project as submitted, we have been told that Senator Fulbright plans to introduce a bill in Congress authorizing work as specified in the project submitted to the Department of Interior.

The university stands ready to cooperate with fish farmers in Arkansas in any way possible. We feel that fish farmers will be interested in basic teaching being done in zoology. Our extension personnel will make available to fish farmers any information which they might have access to as a means of improving fish production. However, the basic question still exists, that in order to do a good job of rice-fish farming in Arkansas, more research information is needed. We feel that the project which has been developed, if activated, could give some very worthwhile answers. We think that the type of job contemplated in the project can best be done by taking advantage of the existing information available from our rice research program. The university stands ready to move forward on the program if satisfactory financial support can be developed.

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Senator YARBOROUGH. Thank you, Dr. White.

Dr. White, are you familiar with the species of fish being grown in the ricefields now in Arkansas?

Mr. WHITE. In a very general way. I would rather Mr. Prewitt would answer questions with reference to that. He is actually producing the fish and he knows more about it than I do.

Senator YARBOROUGH. I believe that Senator Lausche, who is a member of this subcommittee, is interested in knowing whether or not the State of Arkansas would contribute to this program if this law is passed, and if it is being established at the university.

Mr. WHITE. Sir, we feel that our contribution would come about largely through our past work and our future work on plants. We are already financing a rather extensive program in rice culture and related problems on our own crops related to ice, and we hope to continue that work and expand it. We feel very definitely that this fish production question ties right in with our rice farming operation, and as a result we feel that we could eliminate a great deal of duplication if we were working with this problem as a team with, say, the fish biologists and others that might be able to contribute more from the biological aspect.

Senator YARBOROUGH. Where is your experiment station in Arkansas?

Mr. WHITE. At Stuttgart, Ark.

We also contemplate expanding our research program relating to rice and other crops in southeast Arkansas which will involve some different soil types, which is also a fundamental question involved in fish production. Apparently you get some different reaction from fish grown on buckshot or gumbo soil over that grown on the fairly silty loam soil which is fairly typical of our whole rice area. So we feel that we would be in a pretty good position to make a heavy contribution on this agricultural part of this problem, you see.

Senator YARBOROUGH. In determining what species of fish would grow best on what soils?

Mr. WHITE. Well, there would be one problem. Also, another question would be the reaction or the result of fish production on one type of soil with reference to another.

Senator YARBOROUGH. On the fertility of that soil?

Mr. WHITE. That is right; yes, sir. We do not know all of the scientific problems involved but we do know where we have produced fish on these rice soils that we get an increase in nitrogen and organic matter which happen to be two of the major items that create deficiencies in rice production; otherwise, we'd have to add that through chemical processes or plant rotations growing oats or some other crop when we did not have the rice crop on the soil.

Senator YARBOROUH. Thank you, Dr. White, for the statement. It will be made part of the record.

Mr. WHITE. Thank you, sir.

Senator YARBOROUGH. Does the staff have any further questions?

Mr. BAYNTON. No, sir.

Senator YARBOROUGH. Mr. Prewitt?

STATEMENT OF ROY PREWITT, FISH FARMER, LONOKE, ARK.

Mr. PREWITT. I am Roy Prewitt, Senator.

Senator Fulbright has pretty generally covered this program in a broad, general way and Dr. White has——

Senator YARBOROUGH. Identify yourself, please, for the record.

Mr. PREWITT. I am a fish farmer at Lonoke, Ark. I have been in the business of farming fish and rice for 10 years. I am actually an attorney who lost his practice by getting interested in something else.

Senator YARBOROUGH. Lonoke is in the southeast?

Mr. PREWITT. Central part of Arkansas, near Little Rock. It is in the edge of the rice producing area about 18 miles out Highway 70 from Little Rock; you probably passed it along the road.

Senator YARBOROUGH. Go ahead, please.

Mr. PREWITT. Our farmers have had to do a lot of research. We were the first in Arkansas to go into the business of farming fish extensively. While we grow mostly minnows for bait we do grow other fish and there have been lots of problems that we have had to solve because in the beginning we had no source of knowledge to call upon to help solve the problems. Since then, there are sources of knowledge that have helped us. The farmers of Arkansas, Texas, and Louisiana, of all of the flatlands of the South that will hold water where there is a good water supply need to have some more research than we have at present.

I have worked up this proposed research project that was submitted by the university for Saltonstall-Kennedy funds and briefly I am going to run over the objectives and discuss those point by point.

First, determine the species of fish most suitable for culture on a commercial basis in shallow reservoirs and flooded ricelands of Arkansas. That should not necessarily be limited to ricelands because cotton and soybeans and other crops that grow on our flatlands that will—let me say first, land suitable for fish production on a large-scale are flatlands that will hold water where there is a good water supply. We don't know actually what species are the most suitable for culture, for food or even there may be other better sports fishes that we could grow.

Second, to determine methods for production of fingerling fishes for stocking in commercial reservoirs. A lot of research needs to be done on the spawning of certain types of fishes for stocking.

Third, to develop methods for the control of parasites and diseases of brood fishes and of fingerlings prior to stocking. This third is extremely important. Fish, like all living things, are susceptible to diseases and to parasites. When you have them under highly concentrated conditions trying to grow them like, you know, to get the most out of production, then diseases and parasites are very dangerous things.

There has been no research done on those things, diseases and parasites on warm-water fishes. Before we can proceed in the South in growing the fish that we are growing we will have to know a great deal about parasites and diseases.

Fourth, the development of economical methods for raising the more desirable species of fish to marketable size.

An example of what that means, the markets demand certain sizes in fish. We yet don't know how to make them come out, you know, the sizes that the markets demand. We plant a bunch of fish in a field and there is no way yet we know how to make them, you know, come out to fit the particular things.

Mr. BAYNTON. No feed lot operation?

Mr. PREWITT. That is right.

Fifth, to determine the effect of fish-rice rotation, including crops other than rice commonly grown on rice farms, upon both fish and other crops.

This is a big field for research. We know that keeping water on fields at a certain depth we can destroy certain noxious plants that are damaging to rice but we do know also that some other plants sometimes come in these fields that are damaging to rice. We do know that there is some kind of relation between plants and animals. Of course, you have to grow plants before you can grow animals. We do know there is some kind of relation; for example, across the bayou from my farm, a farmer had a field of rice that he would normally have produced 55 bushels to the acre. He had a fishpond adjacent to it and in watering his rice he pumped his water out of the fertilized fishpond on the rice. Theoretically the nitrogen, potassium, and phosphate spent itself producing plants in the fishpond, it might grow organisms, and so forth. But something happened in the rice field. He produced 134 measured bushels per acre indicating that there is some growth factor, some hormone which I think, Senator Yarborough, that the Japanese have noted that, too, that there is something that causes the rice to grow better because the fish are present. I think they say they get 20 bushels more per acre where they put fish right into the rice.

Senator YARBOROUGH. Let me ask you: How long a period of time when you are growing rice, what is the longest period of time that you have water on the land? I am not referring to the year or 2 or 3 years that the land lies fallow, but in the actual growing of the crop in 1 year, when you put water on the rice, how long is the longest——

Mr. PREWITT. Different practices, Senator. Some farmers practice putting the water off the rice and drying it up for some purpose and some farmers now are keeping it on the continuous length of the growth of the rice. But the common practice is to drain off the ricefield about twice.

Now, there are some farmers who in building their reservoirs build their bar pits on the inside and when they pull the water off the rice they pull the fish down into the bar pit and when they flood it back up the fish can go back into the rice.

Senator YARBOROUGH. Well, those who follow this practice of leaving the rice in water for the entire growing period, I believe you said some farmers practice that?

Mr. PREWITT. Yes, sir.

Senator YARBOROUGH. How long would that period be?

Mr. PREWITT. On different species of rice, it is—Dr. White, I believe it is about 60 days?

Mr. WHITE. It varies from 60 to 90 days.

Mr. PREWITT. The short season rice is about 60 days and the long-growing rice about 90 days, I believe. You have a different situation

in Texas. Some of that rice down there, you know, they can just keep on growing it down in the southern part of Texas.

Senator YARBOROUGH. Well, I was thinking of the situation that I saw in Japan, areas where they left the water on the rice for, oh, substantially all of the growing period and were raising small fish in that right while the rice was growing.

Mr. PREWITT. They do that, and they say that their average production is increased 20 bushels per acre of rice by reason of that.

Senator YARBOROUGH. What species of fish is that, for that fast growth?

Mr. PREWITT. I believe that in Japan, it is mostly carp, isn't it, Dr. Meehean?

Mr. MEEHEAN. A good deal of it is carp. There are other species, though.

Mr. PREWITT. Grown in Japan. Asiatic nations grow another type of fish called tilapia. Now, that fish has been introduced into our country and it is being experimented with at the experiment station at Auburn and it is a warm-water species. It probably could be grown in your State of Texas, in the southern part of Texas.

Senator YARBOROUGH. Have you seen those? You are familiar with those?

Mr. PREWITT. I haven't seen them. Some of these men who will testify will tell you about them.

Senator YARBOROUGH. Do you have a written statement?

Mr. PREWITT. I don't have a written statement. I will introduce a statement here, Senator, which I wrote for a magazine which pretty well covers this thing. It was inserted in the Congressional Record by Senator Fulbright, it is about farming fish in the fields.

Senator YARBOROUGH. All right, that will be filed with the record.

(The article referred to follows:)

FISH FARMING IN THE FIELDS

(Extension of remarks of Hon. J. William Fulbright, of Arkansas, in the Senate of the United States, Tuesday, March 27, 1956)

Mr. FULBRIGHT. Mr. President, I ask unanimous consent to have printed in the Appendix of the Record an article entitled "Let's Grow Fish in Our Fields," and published in the March 1956 issue of the Arkansas Farmer.

The author, Mr. Roy Prewitt, is a widely known fish farmer who has an extensive operation near Lonoke, Ark. Largely through the efforts of Mr. Prewitt and others who have pioneered in fish farming, large-scale production of fish has begun on Arkansas farms. Not only has the farming of fish been profitable through the sale of fish in commercial channels, but the program is also contributing to Arkansas agriculture by conserving surface water and by increasing the fertility of the soil in reservoir areas.

There being no objection, the article was ordered to be printed in the Record, as follows:

"LET'S GROW FISH IN OUR FIELDS

"(By Roy Prewitt)

"Large-scale fish production has begun on Arkansas farms. Thousands of acres of fish are now in cultivation. Reservoirs are being built as rapidly as earthmoving equipment can do the job.

"Farmers who ventured into the business a few years ago are now harvesting crops of fish. The yield is better than they are getting for their other livestock.

"Fish farmers are learning (1) improper preparation of reservoirs can raise the cost of harvesting and cut down profits; (2) improper stocking can lower

production; (3) diseases and parasites can reduce production and lower the value of the crop; (4) low-value species—like rats in a feed trough or weeds in a cottonfield—get into the ponds and compete with more valuable species for the available food; and (5) there are marketing problems.

"Fish farming has been helped in Arkansas by the Soil Conservation Service, the Agricultural Extension Service, and by the Alabama Polytechnic Institute. Some agencies and private organizations are still discouraging fish farming.

"NEW CO-OP

"A new step has been taken by fish farmers that will help solve a lot of the problems. A cooperative has been formed—the Arkansas Fish Farmers Cooperative. H. H. Harvill, of Humphrey, was elected president; Steve King, of Lonoke, is secretary. The board of directors is: Taylor Prewitt, of McGehee; P. E. Smith and Frank McCartney, of Newport; George Ryland, of Star City; J. D. McGehee, of Pine Bluff; Marvin Dickson, of Brinkley; and Clarence Lilly, of Lonoke. I am also a member of the board of directors.

"The officers and board members of the organization are pioneers who have made a success in fish farming.

"With the setting up of this agency to work with and speak for all members, things began to happen immediately.

"First, a new respect for fish farmers was created. Fading of organized opposition became noticeable in a few days. Fish buyers became aware of the organization and the price per pound of farm-grown fish increased over wild fish.

"Processing and canning plants became interested, and started negotiations for fish supplies and locations in Arkansas. Dog- and cat-food processors became interested in the trash-fish production.

"Orders began arriving from State game and fish commissions from as far away as Utah for live game fish for stocking purposes. These orders will be filled mostly from farm ponds in the hills that are overstocked with crappie, bream, and bass.

"POND PROFITS

"Correspondence received at the Lonoke office of the cooperative indicated that many States find it more economical to buy fish for stocking than to attempt to grow them. This will make every farm pond in Arkansas a potential source of profit since all of them hatch more fish every year than the ponds will support.

"The board of directors of the co-op has set a membership fee of $1 for owners of ponds of less than 5 acres, and a $5 fee for owners of ponds above 5 acres.

"Inquiries from States about fish for stocking purposes caused the co-op officers to give a closer look at the possibilities of selling surplus game fish from farm ponds to State and Federal agencies. They found that the United States Department of Agriculture is in need of about 30 million game fish a year for stocking purposes. Moves are being made to capture this market. The 40,000 farm ponds of Arkansas could supply that amount.

"An interesting sidelight to the organization of the co-op has been a lower fish harvesting cost. Reservoir owners have employed commercial fishermen to harvest fish—usually on a 50–50 basis. The harvester got half the production for doing the job. Contracts are now going with commercial fishermen getting 25 percent of production for harvesting.

"Fish farming has arrived in Arkansas. Production on a vast scale will always be limited to the level lands of eastern Arkansas. But there is hardly a farm in that State that doesn't have some land adapted to growing fish.

"FISH ARE NEEDED

"During the last 20 years a tremendous change has occurred in our coastal and inland waters. The take of fish from coastal waters is rapidly decreasing. The take of fresh-water fish from inland waters now is almost nonexistent. About 90 percent of our fresh-water fish were supplied from the Great Lakes until the sea lamprey invaded the lakes and destroyed that industry.

"Drainage, flood control, droughts, and restrictive laws have nearly destroyed the fresh-water fish industry in our lakes and rivers. Fresh-water fish are the highest-priced item poundwise on our menus today. The wholesale price of buffalo fish has jumped from 2 to 18 cents a pound in 10 years.

"A tremendous shortage has developed in fish and fishery products, such as fish meal.

"The outlook for fish farming is good. We believe we have taken a step forward in Arkansas by organizing the Arkansas Fish Farming Cooperative. We hope that farmers already growing fish and minnows, and owners of farm ponds and others who are interested in growing fish, will get in touch with the organization through the secretary, Steve King, of Lonoke."

Mr. PREWITT. Here is an article that was done from the Wall Street Journal that refers to a project down in your State of Texas. The Fish and Game is establishing some research down there.

Senator YARBOROUGH. I think we should have both of those in the record.

(The article referred to follows:)

[From the Wall Street Journal, Washington, D. C., March 28, 1957]

ARKANSAS FARMERS ROTATE CROPS OF FISH, RICE TO BOOST PROFITS—CHANNEL CATFISH, CARP, BASS NOW POPULATE RICE PADDIES; TEXAN TRIES AN EXPERIMENT

(By Samuel H. Logan, staff reporter of the Wall Street Journal)

LONOKE, ARK.—Here in east central Arkansas, farmers are cultivating a new cash crop—fish.

Some 500 farmers, mostly ricegrowers whose acreage allotments have been trimmed by Uncle Sam because of rice surpluses, are "tilling" more than 100,000 acres of rice paddies stocked with channel catfish, buffalo, carp, and black bass. That's about double the acreage devoted to fish farming in the State 2 years ago.

The objective is twofold: Revitalization of the soil to obtain bigger per acre yields of the grain next year, and the harvesting of a crop of finny food which can be sold in their local markets at a comfortable profit. Ricegrowers also aim to limit rice production, and thus shore up rice prices, by rotating rice and fish crops. They hope other ricegrowing States like Texas and Louisiana will follow suit.

MEMBERSHIP GROWS

Fish farming, says Steve King, secretary of the 1-year-old Arkansas Fish Farmers Cooperative here, is taking a "tremendous hold" on farmers in the State. Membership in his organization has grown from 50 a year ago to more than 225 now with "new applications coming in every day," he says.

While most of the commercial sale of fish from fish growers in the State thus far has been for human consumption, Mr. King says plans are being discussed by the Arkansas co-op for establishing a processing plant to produce canned dog and cat food.

The acreage in the State which can be devoted to ricegrowing this year has been fixed at 346,000 by the Department of Agriculture, down from 384,000 acres last year. But the soil-bank program has further encouraged farmers to try a hand at fish farming, according to Roy Prewitt, vice president of the Arkansas co-op, since the farmers can grow and sell their fish and still receive acreage allotment payments from the Government. In addition, under the soil-bank program, he says, farmers can receive up to 80 percent of the cost of establishing their rice-fish ponds.

BOOSTS YIELD

Some farmers, however, have found the fish-growing business profitable aside from the Federal Government inducements. W. M. Dickson, a 40-year-old ricegrower near Brinkley, Ark., for example, says he boosted his per acre yield of the grain from 15 bushels in 1953 to 110 bushels in 1956 by growing fish on his 70-acre field in the 2-year interim.

Mr. Dickson had "herded" some 14,000 fish in his field for the 2 years, including 10,000 buffalo, which cost him $1,000, and 4,000 carp and channel catfish which he collected himself. Additional costs, he figures, amounted to about $11,000 for building his 3- to 4-foot levees, installing pipe and water pumping equipment.

When he harvested his fish last March, the crop totaled 717 pounds of salable fish to the acre which netted him an average of 30 cents a pound for a gross return in excess of $15,000. In addition, he raised 160,000 fingerlings from 80

pair of buffalo fish, selling 145,000 of these at $50 a thousand. This brought him another $7,250 for a total gross income from fish of about $22,250.

By comparison, Mr. Dickson figures his income from rice on the same field for 1953 and 1956 amounted to around $22,000, or slightly less than from fish. But more significantly, he adds, the marked gain in rice yield in 1956 stemmed from his fish farming in 1954 and 1955.

THE QUICKEST WAY

"I'm thoroughly sold on the way it builds up the land," he comments. "It's the quickest way."

Mr. Dickson's conclusion is supported by research biologists. Kermit Sneed, research biologist with the University of Oklahoma Research Institute, explains that the fish chew off undesirable grasses in the fields and boost the nitrogen and organic content in the ground. He figures fish hike the nitrogen content of the ground by one-tenth to two-tenths of 1 percent a year.

"There seems to be more value to fallowing ground under water than by rotating other crops or turning it to pasture," agrees Marion Toole, chief aquatic biologist for the Texas Game Fish and Oyster Commission.

The Texas commission is setting up a 40-acre experimental rice-fish tract near Houston after rebuilding a 1,600-acre lake as a water source. John S. Campbell, of the Louisiana Wildlife and Fisheries Commission, observes: "We see some pretty good prospects in it (fish farming)."

"Fish farming" in Arkansas really got its start nearly 10 years ago, recalls Mr. King, when a ricegrower attempted to grow bait fish—shiners, minnows, and goldfish—in one of his paddies. The bait-fish project failed, but he noticed a marked gain in rice yield the following year. That touched off similar experiments among the ricegrowers and has given rise to the present fish-farming movement, he says.

The general procedure is to stock the fish-rice paddies in the spring of the year with 3-inch fingerlings—at the rate of about 150 to an acre in the case of buffalo fish, which is the most widely grown species in Arkansas. When the fish are harvested 2 years later—the recommended length of time—they weigh around 8 pounds and sell for 15 to 18 cents a pound. Channel catfish and bass will weigh less but bring a better price per pound.

Water for the fish ponds is obtained by the farmers from their own natural rain-filled reservoirs or by piping it from nearby streams and bayous.

Mr. PREWITT. Harvesting and preparing fish for marketing is important and we know very little about that in warm-water fish.

Senator YARBOROUGH. Does that complete your statement?

Mr. PREWITT. That completes it.

Senator YARBOROUGH. I didn't want to cut you off. I thought you had a pretty bulky document there.

Mr. PREWITT. I was just reading and commenting from this proposed research project.

Senator YARBOROUGH. This full report that Dr. White had filed with us?

Mr. PREWITT. That is right.

Senator YARBOROUGH. Have you completed your statement?

Mr. PREWITT. I have completed it.

Senator YARBOROUGH. Does the staff have any questions?

Mr. BAYNTON. No questions.

Senator YARBOROUGH. Thank you.

Mr. PREWITT. Thank you.

Senator YARBOROUGH. The next witness is Dr. O. Lloyd Meehean from the United States Fish and Wildlife Service.

STATEMENT OF DR. O. LLOYD MEEHEAN, OFFICE OF PROGRAM REVIEW, UNITED STATES FISH AND WILDLIFE SERVICE, UNITED STATES DEPARTMENT OF THE INTERIOR

Dr. MEEHEAN. My name is Lloyd Meehean and I am in the Office of Program Review of the Commissioner, United States Fish and Wildlife Service. I have a written statement here which I would like to read. I had the opportunity 3 or 4 years ago to head the American delegation to the Indo-Pacific Fisheries Conference in Manila and at that time I visited a number of the fish farming areas in Indonesia, Thailand, and Pakistan.

The culture of fish in ponds is at least a thousand years old. The practice of pond culture is highly developed in Indonesia, Philippines, China, and Japan. In these countries pond culture promises to become an important factor in the search for means of increasing and improving the food supplies of millions who now suffer from malnutrition.

Fish culture in the United States is only 100 years old. Until just recently pond culture of fish has been for restocking lakes and streams depleted of desirable game species. The majority of the fish raised in ponds have been trout, bass, and bluegill, with a few other game fish being produced in certain localities.

While a great deal is known about the pond culture of trout, bass, and bluegills, practically nothing is known about the culture of other species. Furthermore, the game species of fish are not adaptable to culture in ricefields—either because of low production of fish per acre—that is, intensive culture requires high production per acre—food requirements, water temperature requirements, and the fact that most game species cannot be sold because of State laws.

The species best suited to intensive pond culture in the South, with particular reference to ricefields, are fish not commonly of interest to the angler, such as carp, sucker, redhorse, drum, buffalo, catfish, and bullheads. Because these fish are of minor importance to the angler and are not raised in hatcheries, little is known of their spawning habits, diseases, and method and requirements of raising them in ponds. Also, there are limited numbers of these fish taken from natural waters by commercial fishermen and at times the market may be glutted.

There are over 50,000 acres of ricelands in Arkansas alone on which fish are being raised as a crop. There are over a million acres of ricelands in Arkansas and several million additional acres in the South, some portion of which are potential producers of sport and commercial fisheries.

Biological research to determine species best suited for ricefield culture and for determining the best way to raise large numbers of them economically, is urgently needed. Technological research and market development will also be necessary to utilize to the fullest extent the fish that are produced.

The United States Fish and Wildlife Service contracted in 1955, with the University of Oklahoma for research on the culture requirements of the valuable channel catfish. In areas where this fish can be sold, its annual landed value is more than a million dollars. In some States it is by law a game fish and may not be sold. The uni-

versity, using certain facilities at the Federal fish cultural station at Tishomingo, Okla., has made interesting progress in learning about the fish, its requirements out of its native environment, and the possibilities for successful breeding. Some experimental plantings have been made in ricefields near Houston, Tex., and these are being followed carefully to determine such basic things as the rate of growth and the survival to maturity.

The Service is very much interested in the culture of fish in ricefields not only because this will place more high protein food on the market but also because it is a splendid method of conserving soil and water. Personnel of the Service have been of assistance to the Arkansas rice farmers during the past year and a half. In fact, several specialists participated in a symposium on fish culture and fish marketing and development that was organized by the Arkansas rice farmers on January 28 and 29, 1957.

Service personnel have recommended that until more is known about fish culture in ricefields, the species to raise are those which we know something about, such as members of the catfish family. Because of the demand for bait minnows in the South, the farmers also have been urged to concentrate part of their fish production efforts to the culture of minnows. Literature on this subject has been made available for their use.

A Service fish disease expert has made several trips to Arkansas and is available in the future to assist with disease problems.

Recommendations have also been made regarding the marketing problems and methods of freezing, smoking, and otherwise improving the fish for sale. It is my understanding that some of the larger fish-rice farmers are testing some of these marketing methods on a small scale to determine the acceptability of the fish prepared in different ways.

Recommendations have also been made regarding the disposal of certain byproducts of fish culture such as bullfrogs, turtles, and crayfish.

Research is urgently needed if this new industry is to get off on the right foot and to expand as it undoubtedly will. To be successful, the research program should be adequately financed. Cooperation of universities, States, and private fish farmers—including rice farmers—would be desirable and necessary. Certain phases of the program could be handled by various agencies. The extent of cooperation expected is not known and could be determined only after conference.

We estimate that the biological, technological, and market development research on fish culture in ricefields will cost approximately $433,000 for nonrecurring expenditures, that is the development of research facilities and that type of thing and at least $85,000 annual recurring funds.

Senator YARBOROUGH. $433,000 that is to build the proper farms——

Dr. MEEHEAN. Experimental facilities and that type of thing.

Senator YARBOROUGH. That you might have around a conventional fish farm.

Dr. MEEHEAN. Yes, sir.

Senator YARBOROUGH. And $85,000 a year to keep it going. That is your estimate of it.

Dr. MEEHEAN. That is our estimate of it at the present time. Our suggested changes in S. 1552 are contained in a legislative report

which has been submitted and a copy of which you received this morning. That concludes my statement.

Senator YARBOROUGH. Dr. Meehean, do you have before you there a copy of S. 1552?

Dr. MEEHEAN. Yes, sir.

Senator YARBOROUGH. I have a copy here of the penciled-in changes. Generally, the changes you suggest would substitute "The Secretary of Interior" for "Secretary of Agriculture."

Dr. MEEHEAN. Yes, sir.

Senator YARBOROUGH. And then you would delete any specific place for the establishment of this station but would leave in "The State of Arkansas."

Dr. MEEHEAN. That is right.

Senator YARBOROUGH. I presume that the proponents of the bill have no objection there. Senator Fulbright had no objections to that change.

Mr. BAYNTON. Yes, sir.

Senator YARBOROUGH. Does the staff have any questions?

Mr. BAYNTON. No. We might insert at this point in the record, Mr. Chairman, the paragraph in the letter from the Department of the Interior that explains the change from the University of Arkansas the authority to establish it and, if I may, read this short paragraph.

Senator YARBOROUGH. Yes.

Mr. BAYNTON (reading):

> While we believe that this work should be conducted in cooperation or by contract with the University of Arkansas if it can be accomplished most effectively in that manner, we believe it is not in the public interest to restrict the means for such accomplishment, particularly until a sufficient study has been made to determine the best method of accomplishing the object in question.

Senator YARBOROUGH. Dr. Meehean, what is the name of the small fish that the Japanese raise in abundance in the ricefields and harvest when they are relatively small, about as big as your finger; it is a round, almost round like a pike? They harvest them; that is a quick-growth fish raised a short time and they are about that long [indicating].

Dr. MEEHEAN. That is probably the milkfish.

Senator YARBOROUGH. It is marketed in great quantities, served in many meals over there.

Dr. MEEHEAN. That is the one.

Senator YARBOROUGH. What period of time is required to grow that fish up to the size which it is customarily marketed in Japan?

Dr. MEEHEAN. Well, over in the countries over there they leave the water on their rice much longer than they do here, because they don't use any machinery to harvest their rice, so that the fields are wet almost continuously; that is, they never take the water off them, and they leave the water on until the rice is fully mature and drain it down after the rice is harvested, and at that time they take the fish out in little canals around the side of the field.

The fields are much smaller than the ones we have here. They may be, oh, less than an eighth of an acre, for example, or larger.

They use other species over there. Also, they use tilapia, they use a number of species of chilsits which we don't have in this country. There is only one representative, and that is down in Texas.

Senator YARBOROUGH. Can you tell me what fish you are referring to that is representative? What is the American name?

Dr. MEEHEAN. The chilsit; it is the Rio Grande perch. It doesn't range very far north so that it probably couldn't be used.

Senator YARBOROUGH. Is its range limited by temperatures of the warm-water fish?

Dr. MEEHEAN. Primarily. They use a number of species of carp, also, that are taken from the rivers in China and certain parts of India that are put in some of these ricefields. There are about 7 or 8 species of carp of one kind or another, but we don't have access to those species here.

Senator YARBOROUGH. What was the species mentioned earlier in the testimony?

Dr. MEEHEAN. Tilapia.

Senator YARBOROUGH. What type of fish is that? Is it a skin fish or scale fish?

Dr. MEEHEAN. It is a scale fish. It looks very much like our bluegill, like a number of the various perch or sunfish that we have in the South. But it, also, is limited somewhat by temperature range.

Senator YARBOROUGH. Has there been any experimentation to determine whether or not those Asiatic fish would grow here, or grow as well as our native fish?

Dr. MEEHEAN. There has been a limited amount of experimentation. Mr. Swingle, at Auburn, Ala., has experimented with tilapia on a limited scale. The reproduction of those species are very similar to our sunfish, like the bluegill, redear, and so forth, but temperature is a factor in their range. That is, he is having difficulty with winterkill because of the freezing or the coldness of the water in that area. So that it may only have a very limited application.

Senator YARBOROUGH. What is the heaviest production of food fish that you know of in any of these countries per acre per year?

Dr. MEEHEAN. In central Indonesia, at the experiment station at Bogar, the head of the experiment station told me that he got approximately 8,000 pounds to the acre.

Senator YARBOROUGH. 8,000 pounds in 1 year?

Dr. MEEHEAN. In 1 year.

Senator YARBOROUGH. That is 4 tons.

Dr. MEEHEAN. Yes, sir, but the methods that they use for propagating those fish couldn't be used in this country, for sanitary reasons, and the other reason is that we don't have the same species available so that we could make up the kind of a combination that they use there.

Senator YARBOROUGH. Well, that 8,000 pounds; is that by considerable feeding of the fish?

Dr. MEEHEAN. It is primarily by running of sewage through the ponds. That is, they use them as sewage-treatment ponds, primarily.

Senator YARBOROUGH. And raise fish in them?

Dr. MEEHEAN. And raise fish in them.

Senator YARBOROUGH. Now, where they use methods more acceptable to our people, kind of conventional American methods, what is the maximum production you know of in any country per acre per year?

Dr. MEEHEAN. There have been records of production of minnows somewhere in the neighborhood of 4,000 pounds.

Senator YARBOROUGH. In what countries?

Dr. MEEHEAN. In this country.

Senator YARBOROUGH. 4,000 pounds a year per acre?

Dr. MEEHEAN. There is one minnow grower who is producing an average of from 1,000 to 2,000 pounds per acre in his ponds.

Senator YABROROUGH. That has considerable feeding involved in obtaining such production?

Dr. MEEHEAN. That includes both feeding and fertilization of the fish.

Senator YARBOROUGH. I believe there was a statement by an earlier witness that the yield in Arkansas in the ricefields that were used there, averaged about 500 pounds of fish per acre per year. That was in Senator Fulbright's statement.

Dr. MEEHEAN. Yes, sir.

Senator YARBOROUGH. What species of fish are grown in the average ricefield in Arkansas that make up the average yield there of 500 pounds of fish per acre per year?

Dr. MEEHEAN. Primarily buffalo, but I think the production of buffalo fish could be increased considerably if we knew more about it. The other species that offer a lot of promise are the catfishes, both the river cats and 2 or 3 species of bullheads that have some promise.

Senator YARBOROUGH. Have buffalo been grown extensively at any hatcheries anywhere in the country yet?

Dr. MEEHEAN. Not to any extent. The old Bureau of Fisheries did some experimental work on buffalo back about 1912 or 1914 during World War I with some success, but in those days they didn't have access to the information that we have now on methods of handling fish, on fertilizing, and many of the new techniques. So that I think, with some experimental work, the methods could be improved considerably.

Senator YARBOROUGH. Now, in addition to fertilizing the soil and furnishing this new food supply, does this preliminary experimentation indicate that the growing of fish might become such a money crop as to compete with any other crop that might be grown on ricelands while it is being rotated from rice?

Dr. MEEHEAN. Very definitely so. The production of fish in ponds may even exceed the value of certain kinds of crops on a per-acre basis. Some of the production that has taken place in Arkansas is almost equal to——

Senator YARBOROUGH. Pardon one minute. I beg your pardon, I missed that last sentence. Will you please repeat that?

Dr. MEEHEAN. I say that it is possible that the production of fish may exceed in value some of the land crops that are produced in these rice ponds. There have been records of fairly extensive production where the value was approximately the same as that of rice. Even with the present methods.

Senator YARBOROUGH. Even with the present methods, the records of the fish production equaling the value of rice. That is in the United States?

Dr. MEEHEAN. Yes, in Arkansas.

Senator YARBOROUGH. In Arkansas?

Dr. MEEHEAN. Yes, sir.

Senator YARBOROUGH. Does the staff have any further questions of Dr. Meehean?

Mr. BAYNTON. I have no questions.

Senator YARBOROUGH. This is not exactly in the range of this freshwater fish, but has there been any experimentation with reference to growing of shrimp in any of the brackish water along the coast?

Dr. MEEHEAN. No, we haven't done any work on that type of propagation. There was a short experiment conducted by an independent agency in Florida along those lines, but they gave it up in a very short time.

From what I saw of the ponds in Indonesia, where they are growing shrimp and some of the other brackish-water species, there is some promise, but it is a little more difficult to control the water and to control the ponds like you can in fresh water, so that the possibilities are probably not quite as great. However, you would have to experiment to determine that accurately.

Senator YARBOROUGH. Thank you, Dr. Meehean, for this statement. All of those exhibits that you have offered may be made a part of the record there.

The next witness is Mr. Carbine.

Mr. CARBINE. I don't believe I have anything to add to Dr. Meehean's statement unless you might have some specific questions, and I don't imagine you have.

Senator YARBOROUGH. You are with the Branch of Fisheries Biology?

Mr. CARBINE. Yes, sir.

Senator YARBOROUGH. Of the species of fish that are being grown in the ricefields of Arkansas now, which is the most profitable species?

Mr. CARBINE. Right now, it is probably the channel catfish.

Senator YARBOROUGH. Have experiments been conducted there with very many species?

Mr. CARBINE. No, sir. Aside from the species that are of interest to sport fishermen, we have done very little work. We have gotten into the catfish work and are learning a few things about them. But these other species are almost a complete blank in our knowledge. We have never had an opportunity to do any work with them.

Senator YARBOROUGH. The main effort at the Federal fish hatcheries so far has been to raise fish and increase the supply of fish that are attractive to sportsmen for recreational purposes rather than for food?

Mr. CARBINE. Yes, sir.

Senator YARBOROUGH. And this fish farming involves a different concept. It is like raising cattle; you want to get production, you want to get poundage there?

Mr. CARBINE. Yes, sir. It is the same principle. For example, the rice farmers could produce a crop in the 60 or 90 days available to them when the ricefield is flooded if they could pick up a supply of fingerling fish to stock their ponds with. So the same as the cattlemen, some of them buy feeders, feed them for a short time for fat and that would be about the same principle.

Senator YARBOROUGH. Where do these fish farmers get their fish now in Arkansas?

Mr. CARBINE. They raise their own, most of them.

Senator YARBOROUGH. They are channel cat or buffalo? What about buffalo, where do they get those?

Mr. CARBINE. Either raise their own or I imagine some of them are taken from State waters.

Senator YARBOROUGH. There are no buffalo being grown now propagated at Federal fish hatcheries, are there?

Mr. CARBINE. No, sir.

Senator YARBOROUGH. Are you conducting any experiments now at the Federal fish hatcheries with any of these Asiatic species that are raised——

Mr. CARBINE. No, sir, we aren't. It is rather doubtful whether we would. Some of the Asiatic carps Dr. Meehean mentioned, there are about 7 or 8 species, the Asiatics don't even know how to raise them, that is to spawn them artificially. They have to collect them from natural rivers. So if we brought them over here we would have to learn how to raise them. It might not be very economical. In other words, it should be done on the spot.

Now, we have assisted in training some Chinese and Indians in the latest techniques of fish culture and they are back in their own country now working on this sort of thing.

Senator YARBOROUGH. You would have appeared, I presume, for watching those fish to see if they were bringing in any parasites?

Mr. CARBINE. Yes, sir. There are several other things you would have to consider. We have introduced a number of foreign fishes into this country. The common carp is one, and up to now it hasn't been too useful, it has been more harm probably than good. It has invaded our waters and competed with our native species and in many cases has eliminated the native species. So these introductions have to be watched with a great deal of care to prevent their escaping into natural waters.

Now, this tilapia that has been mentioned here is causing a great deal of trouble in some parts of the tropical world because they do multiply fast and grow rapidly and have a tendency to run other species out and to become stunted. That is, there are so many of them that they don't grow very fast.

So there are a lot of things that have to be watched out for before we get into any large-scale program. I think it would be far better to experiment with our own native species first and do a little side work on introduced species.

Senator YARBOROUGH. Thank you.

Mr. Charles Callison is the next witness.

STATEMENT OF CHARLES H. CALLISON, CONSERVATION DIRECTOR OF THE NATIONAL WILDLIFE FEDERATION, WASHINGTON, D. C.

Mr. CALLISON. Mr. Chairman, I am Charles H. Callison, I am conservation director of the National Wildlife Federation with offices in Washington, D. C.

The National Wildlife Federation is an organization of State wildlife federations and sportsmen associations. Those in turn made up of regional and local associations and clubs representing a total membership of 2 million conservation-minded citizens in the United States.

In your own State, Sportsmen's Clubs of Texas, known commonly as SCOT, is our State affiliate organization. And in the State of the Senator from Arkansas it is the Arkansas Wildlife Federation.

Senator YARBOROUGH. They make up the National Wildlife Federation?

Mr. CALLISON. That is right. Those State organizations make up the National Wildlife Federation.

My testimony will be brief. We should like to endorse wholeheartedly the objectives of S. 1552. We think there is a field of research here that contains great possibilities, not only commercial possibilities that would be of advantage to rice farmers and possibly to other farmers, but this kind of a research program certainly would disclose information that would be useful in the culture of other species of fish and in the managementof sports fisheries as well as commercial fisheries.

We should like to make one recomendation with respect to the legislation and that is that the authority for administering the program be placed in the Secretary of the Interior and the Fish and Wildlife Service rather than in the Department of Agriculture.

Last year Congress passed what is known as the Fish and Wildlife Reorganization Act; one of the purposes of which was to consolidate all fisheries functions in the Department of Interior under the Fish and Wildlife Service which in turn is made up of two bureaus, the Bureau of Commercial Fisheries and the Bureau of Sports Fisheries and Wildlife.

We feel that there is an important principle involved here, it is important to centralize all kinds of work having to do with fisheries and wildlife. They are related resources, and that the proper place to do this as has already been recognized by the Congress is in the Department of the Interior and within the United States Fish and Wildlife Service. So, we would endorse the——

Senator YARBOROUGH (interposing). That is the same suggestion we have from the——

Mr. CALLISON. That it be served by the Department of Interior.

We also believe that the Fish and Wildlife Service and the State game and fish departments have within them competent organizations of biologists, fisheries biologists, and research men and that it would be economical to centralize the work in those agencies rather than attempt to set up a separate staff or organization in another agency of Government to do that.

That completes my statement on this legislation, Mr. Chairman.

Senator YARBOROUGH. How many different State organizations did you say your National Wildlife Federation represents?

Mr. CALLISON. Presently we have statewide affiliate organizations in 47 States, the Territory of Alasaka, and the District of Columbia.

Senator YARBOROUGH. Does the staff have any questions?

Mr. BAYNTON. No, sir.

Senator YARBOROUGH. Thank you for your statement.

Mr. CALLISON. Thank you, sir.

Senator YARBOROUGH. And you are supporting this legislation?

Mr. CALLISON. Yes, sir; we are supporting the legislation with the one recommended change.

I appreciate the opportunity to have presented our views.

Senator YARBOROUGH. Thank you.

Mr. Charles Jackson of the National Fisheries Institute.

STATEMENT OF CHARLES E. JACKSON, GENERAL MANAGER, NATIONAL FISHERIES INSTITUTE, INC., WASHINGTON, D. C.

Mr. JACKSON. Mr. Chairman, my name is Charles E. Jackson, general manager of the National Fisheries Institute, Washington, D. C. Our membership is composed of about 600 firms engaged in the production, processing—including freezing, canning, smoking, salting, pickling, and so on—and also the byproducts industry which consists mostly of a reduction of certain species of fish into meal and oils and solubles, and the latter is used in agriculture for feeding of poultry and swine and cattle, and so on.

The National Fisheries Institute is in favor of the principles of S. 1552. However, we strongly urge that the authority of all phases of fishery programs and research including agriculture be placed under the jurisdiction of the Fish and Wildlife Service of the Department of Interior and all phases of rice culture and other agricultural crops be placed under the jurisdiction of the Department of Agriculture.

These two departments are at present cooperating on a number of projects of mutual interest and responsibility and I am convinced would go along on the same principle.

The bill indicates that the University of Arkansas is particularly interested in research and experimentation of rice and fish culture. Senator Fulbright, the author of the bill, and the University of Arkansas are to be congratulated in taking leadership in this promising field of research. However, it is suggested that other universities as well as other State and private research organizations should also be available for contracts with the Federal agencies specified.

The experience of the fish and rice culture has proven quite satisfactory in relieving protein food shortages in a number of tropical countries. The Food and Agriculture Organization of the United Nations has cooperated with the Dominican Republic, Haiti, Burma, India, Pakistan, and Philippines, Thailand, and other nations to this end.

In most cases the fish produced consist of such so-called rough species, as carp, buffalo, and similar local species. In the underdeveloped countries these species are a welcome addition to the diet of the population. In the United States it would be more desirable to produce other species such as catfish, blue gills, bream, and other pan fishes. The markets for carp and buffalo in the United States is on the decline and since many citizens are already engaged in the pond culture of carp and buffalo fish in Wisconsin and other Middle Western States and in North Carolina and other Southeastern States, a large increase in these species might demoralize the existing markets. There are limited opportunities for buffalo fish for smoking, but overproduction would bring economic difficulties for existing industry.

At Senator Fulbright's request I made contact with some of his people with the industry representatives in New York and discussed with them the possibilities of the use of buffalo for smoking but there are definite limitations unless we have a promotional program to increase the sale.

On the other hand, there is an increasing demand for catfish, bream, and pan-fish species which could probably be produced in the areas envisaged in this bill. Some of the States prohibit the sale of such

game species as blue gills, bream, etc. Most States prohibit the sale of black bass, and the Federal Government prohibits the interstate transportation of black bass from States prohibiting its sale. Trout of all species, on the other hand, are produced in hatcheries and may be sold under strict regulations. Trout culture is an important industry in this country. Likewise, pheasant may be produced in hatcheries and sold for food. It would seem that under proper controls, certain game species produced in rice areas, ponds, etc., should be available for sale, both for food, and for game fish stocking of public and private waters.

Pond culture has already proven successful on an increasing number of farms in America. I believe there is a great future for fish farming in America and that legislation should be enacted to undertake the necessary research to lay down a firm foundation for a new industry that could well supply the protein needs of the population, particularly in those areas remote from salt water.

Furthermore, we feel that every encouragement should be given to the production of brackish and salt-water fish and shellfish but we recognize there is need for research.

If the amendments can be included along the lines suggested the National Fisheries Institute would strongly favor such legislation as S. 1552.

Senator YARBOROUGH. Mr. Jackson, you mentioned the buffalo, the market might be demoralized with the artificial production of buffalo. Did you say they are grown commercially in Wisconsin and some other States?

Mr. JACKSON. I don't know, Senator, whether they are grown commercially, but they are caught, wild fish, but the market is pretty well saturated.

Senator YARBOROUGH. What do they call them in the restaurants?

Mr. JACKSON. They are mostly in the Middle West, I don't frankly know how they list them on the menu.

Senator YARBOROUGH. I will ask you experts, does anybody know in the marketing of buffalo what they are called on the menues?

Mr. PREWITT. In the few places in the South you will see them on the restaurant menues at times, actually you see very few on the fresh water markets because it is a seasonal thing, there is only the certain season in the spring when they are very plentiful that you find them at all.

Senator YARBOROUGH. Do you know about what the harvest is a year now of the fish grown commercially, fresh-water fish from these ricefields in Arkansas and any other places?

Mr. JACKSON. No, sir.

Senator YARBOROUGH. Do any of you witnesses that testified know what is the average annual crop now in poundage?

Mr. PREWITT. No one is keeping a record of it, Senator. The total amount of pounds is not available because there is no agency that's like, for instance, you know how many broilers are being marketed, you don't know how many fish are being marketed. The farmer drains the pond, sells part to one market and part to another market.

Senator YARBOROUGH. When he drains his pond to start putting his rice back into production, does that mean harvest the crop of fish?

Mr. PREWITT. He harvests them a lot of times. For example, he harvests them when he gets orders for fish, when the demand is great,

sends part of them out, and at some specific or stated time he brings the market to the entire production. Sometimes one farmer that I know, he has 640 acres square on absolutely flat land cut into 4 ponds. He grows rice on half of that and fish on half of it, and he moves the water around and the fish around, and he has rice growing now and has his fish pulled down in these bar pits on the inside and he is harvesting these fish and his rice is growing at the same time. The rice is growing on the high land in the center and the fish go down in the excavated bar pit.

Senator YARBOROUGH. What do they do, go out at night and forage up through the shallow parts?

Mr. PREWITT. No, sir; the way rice is grown in Arkansas, and in Texas too, for that matter, it is planted so thickly that nothing but extremely small fry could work their way out in it.

Senator YARBOROUGH. Any questions by the staff?

Mr. BAYNTON. No questions.

Senator YARBOROUGH. Thank you, Mr. Jackson.

Mr. JACKSON. Senator, may I say as I understand it this bill also provides for researching to ultilization of these products, and there should be opportunities for use of fish, possibly, and the feeding of farm animals. So I think there is a great opportunity here to conduct research which may well take care of any extra production that will be produced. When I speak of buffalo, I think mainly of carp. That is used for religious food, the Jewish people use quantities of live carp. There used to be a considerable industry from the West, and now North Carolina ships live carp to Philadelphia and New York for that purpose. The trend toward packaging fish seems to have that market declining, so we would like for consideration, of course, to be given to any economic phases in developing tramendous new supplies; research to find uses for those should go along with it.

Senator YARBOROUGH. Thank you, Mr. Jackson, for that statement.

Any further documents any witnesses desire to offer? Any further witnesses whose names were not on the list who desire to be heard on this bill?

We will keep the record open for a few days. If any of the witnesses have any additional documents they would like to add, they may do so in that time.

We have a letter from Congressman Trimble in favor of the bill. I would add that letter to the record.

(The letter from Congressman Trimble is as follows:)

HOUSE OF REPRESENTATIVES,
Washington, D. C., July 5, 1957.

Hon. RALPH YARBOROUGH,
Chairman, Senate Interior Subcommittee,
United States Senate, Washington, D. C.

DEAR SENATOR YARBOROUGH: I understand your subcommittee is to hold a hearing on July 8 on S. 1552 by Senator Fulbright, of Arkansas. The bill is to establish a fish farming experiment station in Arkansas.

I wish to go on record as supporting Senator Fulbright's bill. I hope it can be given favorable consideration by your subcommittee.

Sincerely yours,

J. W. TRIMBLE.

Senator YARBOROUGH. And the Sport Fishing Institute of Washington, D. C., favors the bill as amended. We will add their statement to the record.

(The statement of the Sport Fishing Institute is as follows:)

SPORT FISHING INSTITUTE,
Washington, D. C., July 5, 1957.

Senator WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
Senate Office Building, Washington, D. C.

DEAR SENATOR MAGNUSON: The Sport Fishing Institute would be pleased to personally present a statement in favor of S. 1552 on July 8. However, due to travel schedules, we will not be in the city at that time.

Therefore, we wish to submit the attached statement which we request you introduce into the record. Thank you very much for doing this.

Sincerely,

E. A. SEAMAN, *Executive Secretary.*

STATEMENT BY SPORT FISHING INSTITUTE, WASHINGTON, D. C.

The Sport Fishing Institute looks with favor upon the purpose of this bill. We disagree that the Department of Agriculture is the appropriate agency. The logical agency seems to us to be the United States Fish and Wildlife Service as recently reorganized by the Fish and Wildlife Act of 1956. We recognize that there are thousands of potential acres of sport-fishing waters now available, and will be available, in conjunction with rice production. Although the primary purpose of rice-fish production, as this bill concerns itself, is for rice and commercial fish, we believe that significant sport-fishing values may also be developed as a byproduct of rice paddies managed in this manner.

The possible use of rice ponds as additional places to go "out fishing," for a daily fee, should be recognized in addition to development of primary commercial fishing potential. The Sport Fishing Institute believes that any research and experimental development methods of managing fish with rice undertaken by the Federal agencies so authorized should consider important sport as well as food fish.

It seems likely authorization already exists whereby the United States Fish and Wildlife Service can undertake studies of this sort in conjunction with the University of Arkansas—if additional funds are made available. In any case, we are opposed to any attempt to dilute the responsibilities of this organization by authorizing the Department of Agriculture to undertake this type of research program. So-called Saltonstall-Kennedy funds seem to us to be the logical source of funds to be utilized for this project since it is primarily a commercial fishing venture whether it involves marketable food fishes or a "fish-and-pay" type of "sport" fishing.

Senator YARBOROUGH. We will add to the record the statement from the Department of the Interior on the bill and the appendage to that, A Summary of World Fish Farming.

(The document referred to is as follows:)

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D. C., July 5, 1957.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
United States Senate, Washington, D. C.

DEAR SENATOR MAGNUSON: Your committee has requested a report on S. 1552, to authorize the Secretary of Agriculture to establish a program for the purpose of carrying on certain research and experimentation to develop methods for the commercial production of fish on flooded rice acreage in rotation with ricefield crops, and for other purposes.

If amended as suggested in this report, we would be agreeable to the enactment of this proposed legislation. In this connection, however, we note that the comparatively recent Fish and Wildlife Act of 1956 (70 Stat. 1119) contains authority to perform the type of functions to which this bill relates.

In our opinion, the objectives of S. 1552 are sound and important, but its designation of the Department of Agriculture as the administrator of the program would be inconsistent with the principle contained in section 6 (a) of the Fish and Wildlife Act of 1956. This section of the act directs the

transfer from other departments of those functions relating "primarily to the development, advancement, conservation, and protection of commercial fisheries; * * *." In the circumstances, because this proposed legislation involves primarily matters of research and experimentation concerning fishery matters, enactment of this bill in its present form would be a backward step toward dividing fishery functions between agencies and providing for overlapping and duplication.

There are about 100,000 acres of ricelands in Arkansas alone, on which fish are being raised as a crop. There are a million acres of ricelands in the South which are, potentially, producers of sport and commercial fisheries. Among the deterrents to improved fish production on these lands are the following:

1. The laws of most States prohibit the sale of certain species of fish designated as game fish; however, these are the most desirable and most marketable species.
2. Uncertain or lack of reproduction of desirable species in ponds.
3. Lack of knowledge needed for diagnosis, prevention, or treatment of diseases of warm-water fish.
4. Limited marketability of common pond fish, such as carp and buffalo, which are nongame species.
5. Lack of technological advances in preparation, packaging, storage, and merchandising of freshwater pond fish.

All of these deterrents may be removed, at least in part, by remedial State legislation, biological and technological research, and market development efforts. The objectives of this proposed legislation could be accomplished most effectively under the terms of this bill and in a manner consistent with existing legislation by authorizing this Department to accomplish the research and by providing for coordination and cooperation by the Department of Agriculture in these matters.

We suggest, accordingly, the following amendments to this bill:

(1) On page 1, line 3; on page 2, line 19; and on page 3, line 7, strike out the word "Agriculture" and substitute in lieu thereof the words "the Interior."

(2) Page 1, lines 4 and 5, strike out the words "contract with the University of Arkansas for the establishment of" and insert in lieu thereof "establish".

While we believe that this work should be conducted in cooperation or by contract with the University of Arkansas if it can be accomplished most effectively in that manner, we believe it is not in the public interest to restrict the means for such accomplishment, particularly until a sufficient study has been made to determine the best method of accomplishing the object in question.

(3) Page 3, lines 3 and 4, strike out the words "The United States Fish and Wildlife Service of the Department of the Interior", and substitute in lieu thereof the words "The Department of Agriculture".

(4) Amend the first line in the title of the bill by striking out the word "Agriculture" and inserting in lieu thereof "the Interior".

There is enclosed a copy of supplementary information on fish farming, also requested by your committee.

We have been advised by the Bureau of the Budget that there would be no objection to the submission of this report and supplementary information to your committee, but that such advice should not be construed as reflecting any commitment as to the necessity of any appropriations beyond those contained in the 1958 budget to carry out the purposes of the proposed legislation if enacted.

Sincerely yours,

HATFIELD CHILSON,
Under Secretary of the Interior.

A SUMMARY OF WORLD FISH FARMING

The most authoritative and complete recent information on world pond fish production and practices has been made available by the Food and Agricultural Organization of the United Nations. From that and other sources we can catalogue many interesting and little-known facts:

1. At least 40 different species of fish are cultivated.
2. Production figures range from a few pounds of wildfish per acre to 3 tons of cultivated fish per acre per year.
3. Fish culture in ricefields has improved rice production in all cases. In Japan, for instance, carp, in addition to tillage, eat weeds and insects and the

remains of food provided for the fish and the excrement from the fish has a fertilizing effect on the rice. In China, yields have been increased by 10 to 15 percent by fish control of rice stem borers. And in Malaya, the fish eat algae from the bottom of the ricefield, increasing production by 10 percent.

4. If, on the 200 million acres of land producing the world's supply of rice, the wildfish alone were harvested, the potential production of such fish would be at the rate of 240,000 tons per year.

5. In some countries nearly the entire population depends upon fish as a daily source of animal protein.

6. The Asian countries where pond fish culture is most extensively practiced are China, with 500,000 acres; Indonesia, 460,000 acres; Philippines, 250,000 acres; India, 220,000 acres; Formosa, 20,000 acres; and Japan, 13,500 acres.

7. In the Philippines, young fish (fingerlings) for pond stocking sell for $200 to $250 each 10,000. Nursery ponds are stocked at the rate of 120,000 to 200,000 per acre.

8. Introduction of Tilapia added 5,000 tons per year to Java's fish production.

9. Many of the pond fishes will not spawn in captivity—ponds thus are not usually self-sustaining but must be restocked with wild young.

10. The Indo-Pacific region has never had a disastrous fish mortality from disease, but introduction and transplantations made such a possibility a greater threat than ever before.

11. In Europe, prewar Germany was the center of carp and trout culture with about 125,000 acres of ponds and production of a quarter of a million pounds of trout and about 20 million pounds of carp a year.

12. There are about 350 commercial trout growers in the United States; there are no production, sale, or value figures for these.

13. One commercial minnow and goldfish grower in the Middle West produces and sells over 30 million fish a year, employs a large staff including biologists, feeds tons of fish food each year, undertakes extensive fish disease and predator control, and makes substantial profits.

Most surprising perhaps, is the fact that there is no established science of fish husbandry for warm-water species comparable to the husbandry of other animals—chickens, turkeys, rabbits, hogs, and cattle. Oriental fish culture is a blend of ancient tradition in the Chinese style and practices handed down from one generation to another.

Despite the proved productivity potential of warm waters properly managed, there are vast areas of fresh and brackish waters in the world that are neglected or, at least, little used. Most of the pond culture is for family subsistence rather than organized commercial venture. Notable exceptions are in Japan, middle European countries like Germany, Poland, and Czechoslovakia, and the Philippines. Generally speaking, though, the world's cultivated pond fish are produced for their animal protein food, in the absence of sufficient other kinds; with family or other cheap labor; with fertilizers and feeds which are otherwise inedible or surplus domestic or farm waste products; and in conjunction with other primary farming activities like sheep or pig raising, rice culture, or poultry farming.

Research to improve pondfish culture has received but little, if any, attention in most of the Orient. Exceptions are in Malaya, where extensive research programs have been undertaken in recent years, and in Indonesia, where the Dutch assigned research teams to study and improve pond culture many years ago. The Indonesian Government is continuing with this research program. FAO makes Indonesia the site for their in-service training school for pond culture.

Research on pond culture in Europe has progressed to the point where pond culture is on an almost equal footing with other animal husbandries. In fact, the only textbooks on pond culture available in the entire world are European.

The species of fish raised in ponds in Europe and the Orient, except for the common carp, are unavailable in this country. Many of the species are tropical in distribution and will not live here. Other species have undesirable habits and would become a nuisance (the common carp, for example) if introduced into this country and allowed to escape. Far more important, from the standpoint of the American consumer of fishery products, is that most of the pond species raised in other countries are not palatable or otherwise desirable and would have little or no market value in this country.

Although Americans may learn much from the time-tested methods of foreign-fish farming, it is immediately evident that an American fish-farming business must, to be sustained profitably, be geared to the American economy. Briefly, at least the following considerations are important:

1. Americans are not big fisheaters.
2. The species of fish cultivated must be carefully selected for good consumer acceptance and sustained marketability.
3. Labor costs are high.
4. American public-health standards will not permit the same methods of fertilization and feeding of fish as those used in other countries.
5. Sales of fresh fish in the round are declining throughout the country as new methods of preservation, preparation, packaging, storing, and merchandising are introduced.
6. Some of the finer food fish which might be cultivated commercially are legally designated by States as game fish. The black basses and the channel catfish are two examples of these.
7. Markets for so-called rough fish like buffalo fish and carp are easily glutted because of their ready availability in the wild.
8. There are about a million acres of ricefields in production in the Southern States, most capable of fish production.

Research on fish-hatchery production in the United States has been concentrated mainly on production of bass, bluegill, trout, and salmon for stocking of lakes and streams. Most of these fish are raised to fingerling size. Producing fish to commercial size requires different techniques and facilities. Furthermore, the same species of fish presently produced in hatcheries are not suitable for pond production because expensive artificial feeding is required and water temperatures in all but the northern tier of States would not be suitable. Other native American fish must be found which would be suitable for pond culture. Research will then have to be undertaken to obtain the facts necessary for placing the pondfish industry on a sound basis similar to any other animal husbandry. Successful American fish farming for profit will depend upon a fund of knowledge about—

1. The quality of the water used.
2. Methods of control of water levels, erosion, siltation, and pollution.
3. Control methods for vegetation, overpopulation, predators and competitors, intrusion of undesirable species, diseases, and parasites.
4. Carrying capacity of the water; stocking levels.
5. Fertilization of the water.
6. Nutritional requirements of the fish; feeding materials and methods.
7. Spawning requirements of the fish, provision of suitable spawning conditions and areas, means for stimulating spawning in captive fish.
8. Availability of dependable brood stock.
9. Requirements for rapid growth or, in ricefields, for growth to market size during the period of flooding.

Research is the key to knowladge. There is little backlog of research findings upon which we can draw for guidance in embarking on any large-scale, sustainable, commercial fish farming. Pondfish culture research has been centered very largely at the Alabama Polytechnic Institute at Auburn, and has been concentrated on small farm pond culture of black bass and bluegill sunfish, particularly establishment of stocking ratios and the maintenance of balanced populations, primarily for sport fishing. Here we are concerned with other species of food fish in large bodies of water for sale, not sport.

The United States Fish and Wildlife Service contracted in 1955, with the University of Oklahoma for research on the culture requirements of the valuable channel catfish. In areas where this fish can be sold, its annual landed value is more than a million dollars. In some States it is by law a game fish and may not be sold. The university, using certain facilities at the Federal fish-cultural station at Tishomingo, Okla., has made interesting progress in learning about the fish, its requirements out of its native environment, and the possibilities for successful breeding. Some experimental plantings have been made in rice fields near Houston, Tex., and these are being followed carefully to determine such basic things as rates of growth and survival to maturity.

Establishment of a research center in the South for study of all aspects of fish farming possibilities will build up a fund of knowledge over the next few years from which commercial fish growers can draw.

To be successful, the research program should be adequately financed. Cooperation of universities, States, and private fish farmers (including rice farmers) would be desirable and necessary. Certain phases of the program could be handled by various agencies. The extent of cooperation expected is not known and could be determined only after conference. States, although interested in this work, probably could not use sportsmen's license funds which support their activ-

ities, on a commercial venture and it would probably be necessary for the legislatures to appropriate money.

REFERENCE MATERIAL ON FISH FARMING

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A southern laboratory for fish farming research—Estimated costs

Capital expenditures (nonrecurring):	
Lands	$25,000
Preliminary engineering	10,000
Laboratory, office buildings	100,000
Garage, storage, and shop	20,000
Residences (2)	33,000
Domestic water supply and sewage disposal	5,000
Pond construction (30 acres total)	150,000
Wells, pumps, and piping	15,000
Scientific apparatus	20,000
Vehicles, tools, and fire fighting equipment	15,000
Roads, landscaping, and fencing	10,000
Engineering and contingencies	30,000
Total	433,000

A southern laboratory for fish farming research—Estimated costs—Continued

Average annual expenses (recurring):

Staff: Director, microbiologist—parasites and diseases, botanist—plant relationships, physiologist—induced breeding, statistician—crop yield studies, geneticist—selective breeding, biochemist—conversion of fertilizer to food to flesh, clerical (2), maintenance (5).

Salaries	$60,000
Other	25,000
Total	85,000

Senator YARBOROUGH. That completes the hearing today.

As I previously stated the record will be kept open for a few days if any of the witnesses desire to add any additional exhibits to their testimony.

I want to thank you gentlemen for the information presented here. I feel that this is an important hearing from the standpoint of developing a new American industry and I feel certain that that development is coming in the course of time. I personally hope that it isn't too long delayed. I think it has a great potential to this country to add to its food supplies and to the utilization of the soil.

Thank you gentlemen for this testimony.

The subcommittee is adjourned.

(Whereupon, at 11:50 a. m., the subcommittee was adjourned.)

(The following was received later for the record:)

COMPTROLLER GENERAL OF THE UNITED STATES,
Washington, April 2, 1957.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
United States Senate.

DEAR MR. CHAIRMAN: Further reference is made to your letter of March 22, 1957, acknowledged on March 25, requesting the comments of the General Accounting Office, concerning S. 1552, 85th Congress, 1st session, entitled "A bill to authorize the Secretary of Agriculture to establish a program for the purpose of carrying on certain research and experimentation to develop methods for the commercial production of fish on flooded rice acreage in rotation with ricefield crops, and for other purposes."

We have no special information or knowledge as to the need for or desirability of the proposed legislation and, therefore, we make no recommendation with respect to its enactment.

Sincerely yours,

JOSEPH CAMPBELL,
Comptroller General of the United States.

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D. C., April 15, 1957.

Hon. WARREN G. MAGNUSON,
United States Senate, Washington, D. C.

DEAR SENATOR MAGNUSON: Thank you for your letter of March 25, concerning S. 1552, to authorize the Secretary of Agriculture to establish a program for the purpose of carrying on certain research and experimentation to develop methods for the commercial production of fish on flooded rice acreage in rotation with ricefield crops, and for other purposes.

While we do not now have firsthand data on fish-rice culture we have reports from Indonesia, China, and Japan on this subject, these reports have been studied and this work is being followed closely by members of our staff. This method of farming has been highly successful in other countries. We have information also that the University of Arkansas, through their school of agriculture,

became interested in the problem several years ago. The rice farmers needed assistance; it is presumed that the university was the logical place for them to go. At that time the rice farmers also called upon this Department for assistance and several of our people have surveyed the area to determine the problems involved.

There are fish-rearing facilities in the South now for research and experimentation with channel catfish. As research progresses, there will be made available information and techniques needed for establishment of successful commercial hatcheries to provide good-quality fish for stocking flooded ricefields for ultimate sale. Meanwhile, future dependable hatchery propagation and profitable commercial fish cultivation will depend upon research. At present we are unable to culture some of the species of fish suitable for rice-paddy culture. We need to learn more about the species combinations most desirable for growing in ricefields. There is also a need for information which will permit orderly marketing and storage of the fish that are produced. Most of the species which lend themselves to pond culture of this type are not the most desirable species commonly eaten by the American public nor found in the fish markets. New methods of preparation must be found. Such a research program should be cooperative between the State agencies and institutions and the Department of the Interior.

We shall, of course, submit our recommendations to your committee on S. 1552 as soon as possible. Please be assured of our interest in this matter and desire to be of all possible assistance to your committee.

Sincerely yours,

ROSS LEFFLER, *Assistant Secretary.*

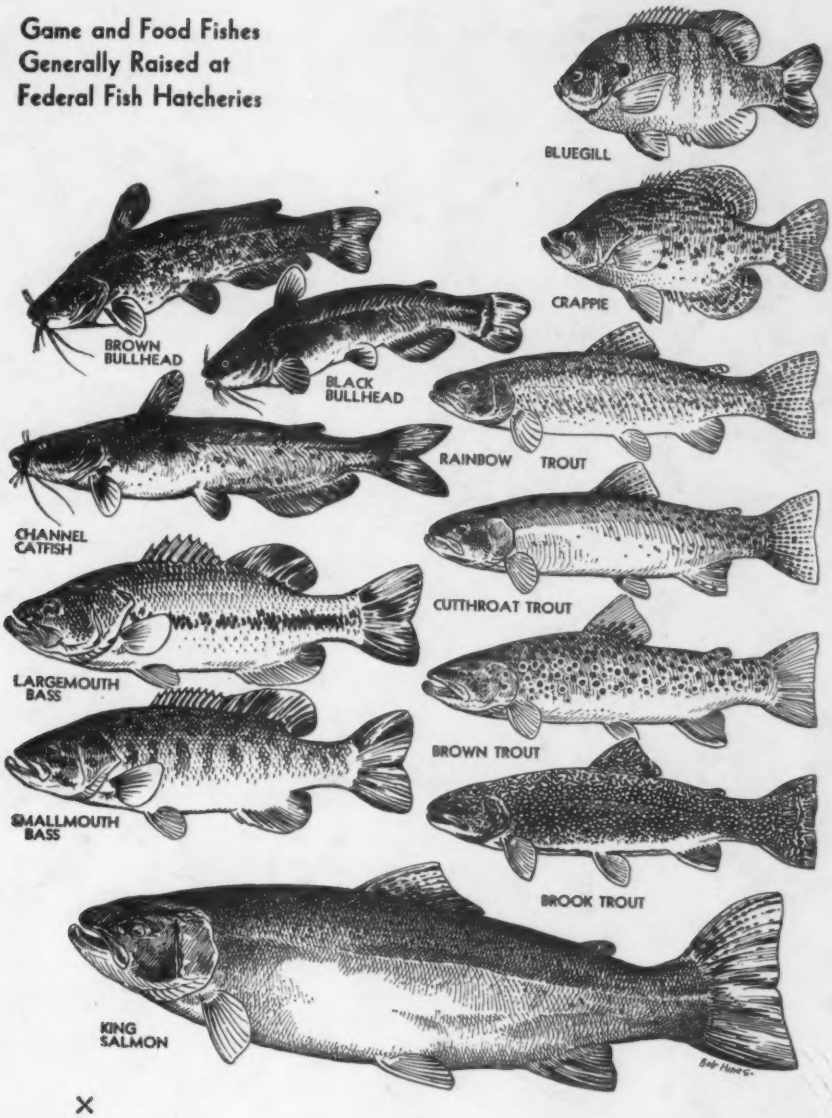
UNITED STATES DEPARTMENT OF JUSTICE,
OFFICE OF THE DEPUTY ATTORNEY GENERAL,
Washington, D. C., March 29, 1957.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
United States Senate, Washington, D. C.

DEAR SENATOR: This is in response to your request for the views of the Department of Justice concerning the bill (S. 1552), to authorize the Secretary of Agriculture to establish a program for the purpose of carrying on certain research and experimentation to develop methods for the commercial production of fish on flooded rice acreage in rotation with ricefield crops, and for other purposes.

The bill has been examined, but since the subject matter thereof is not related to any of the activities of the Department of Justice, we would prefer not to offer any comment concerning it.

Sincerely,

WILLIAM P. ROGERS, *Deputy Attorney General.*

Game and Food Fishes Generally Raised at Federal Fish Hatcheries